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Finger Vein Weightage Calculation of Imaginary Curve between Minutiae Points for Person Recognition

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Abstract: ***Biometric is used in computer science as a form of identification and access control. Out of all techniques of biometric finger vein extraction is most effective method. The paper describes the various research done on finger vein till date. We are using a unique combination of the curvature points and mathematical curve analysis along with the minutiae point extraction methods for veins biometric. The minutiae point extraction method is used to extract the finger vein skeleton, which is followed by the joining points of the skeleton lines. The deep curve analysis will give the curvature intersections, curvature points and the information about the angles, curve length and other curve properties in order to extract the perfect features from the finger vein image.***

Keywords: Finger-vein recognition, Biometric structure feature, minutiae point extraction methods, curvature point, mathematical curve analysis

1. Introduction

The biometric systems are the most widely used personal authentication system in the organization. These systems are used on the main entries, server room entries and to protect the other confidential places from the unauthorized persons. The biometric systems are based on fingerprints, finger vein, palm print, palm vein, iris, retina, etc. The finger vein is one of the most popular authentication scheme among other biometric properties. The preprocessing is very important factor for the finger vein authentication. The processing techniques are used to obtain the finger vein skeleton from the image. The finger vein feature extraction is a process of extracting the finger vein skeleton from the finger vein print image obtained from the personnel using the biometric device for finger veins. In the existing paper "Structure Feature Extraction for Finger-vein Recognition" of year 2013 published in IEEE journals, the authors have extracted the finger vein features using the minutiae points on the basis of the structural elements. The algorithm has performed better than the existing one, but still carries a wider space of improvement. Also this algorithm carries some shortcomings, which are the reason behind the performance lag.

A key advantage of biometric authentication is that biometric data is based on physical characteristics that stay constant throughout one's lifetime and are difficult (some more than others) to fake or change.[2] Biometric identification can provide extremely accurate, secured access to information; fingerprints, finger vein and iris scans produce absolutely unique data sets (when done properly). Automated biometric identification can be done rapidly and uniformly, without resorting to documents that may be stolen, lost or altered. It is not easy to determine which method of biometric data gathering and reading does the "best" job of ensuring secure authentication. Each of the different methods has inherent advantages and disadvantages. Some are less invasive than others; some can be done without the knowledge of the subject; others are very difficult to fake.

The personal identification using hand and finger vein has gained more and more research attentions these years [1]. There are many good properties of this kind of biometric feature:

- The vein information can represent the liveliness of an object;
- It is difficult to be damaged and modified as an internal feature;
- It is difficult to simulated using a fake finger. Because of these, hand and finger vein seems a better biometric feature that finger print and face.

The vein of finger is a kind of biometrics and the vein pattern of finger is unique to each individual[3]. Apart from size, the pattern does not change over time. This feature makes it suitable for one-to-many matching, for which fingerprint and face recognition may not be robust. Among all the biometric techniques, finger recognition is a topic worthy to receive further investigation since this technology overcomes a version to fingerprinting and related privacy concerns, which its traditional association to criminal activity is nonexistent. The finger vein recognition works by identifying the subcutaneous vein patterns of individual's and finger vein is difficult to replicate because they lie under the skin surface.

A finger vein characteristic has gained more interest in authentication because of its uniqueness even between twins[5]. Furthermore, it will not vary during the person's lifetime and impossible to read or copy since it lies under the skin. The most important advantage of finger vein is that it is exist only for live humans. In the finger vein recognition system, the vascular patterns of an individual's finger is personal identification data[3], as a finger has a broader and more complicated vascular pattern and thus contains a wealth of differentiating features for personal identification. The finger is an ideal part of the body for this technology; it normally does not have hair which can be an obstacle for photographing the blood vessel pattern, and it is less susceptible to a change in skin colour, unlike a finger or the back of a hand.

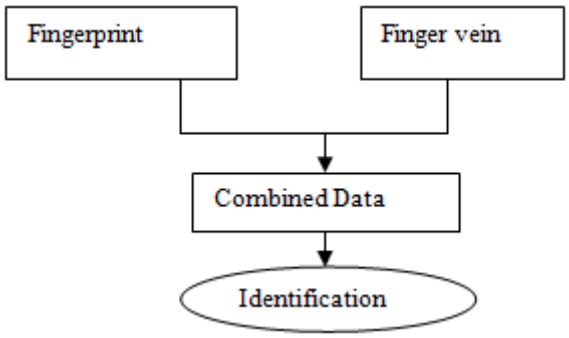

Figure 1: The general Block diagram of the system

Figure 2: Finger vein scanning system

2. Related Work

The research done so far on this technique shows that it has a wide scope of research in the coming years by picking up the flaws and correcting them so that we get a better system to use this technique.

Jinfeng Yang[1] proposed a new finger-vein image matching method based on structure feature. To describe the finger-vein structures conveniently, the vein skeletons are firstly extracted and used as the primitive information. Based on the skeletons, a curve tracing scheme depended on junction points is proposed for curve segment extraction. Next, the curve segments are encoded piecewise using a modified included angle chain, and the structure feature code of a vein network are generated sequentially. Finally, a dynamic scheme is adopted for structure feature matching.

Prabhakar[2]said that Finger vein technology is the newest biometric technology which utilizes the vein pattern which is hidden under the human finger for identification. As these patterns are hidden under the skin surface, they provide a huge privacy consideration, and are hence extremely difficult to forge. An approach to perform finger vein identification based on extracting minutiae features and the spurious minutiae removal is presented in this work. Minutiae feature extraction includes the extraction of end points and bifurcation points from the skeletal patterns of vein and the removal of spurious or false minutiae, makes the identification more accurate.

A paper published by Qing Rao[3] propose a structured personal identification approach using finger vein Location and Direction Coding(LDC). First of all, they design a finger vein imaging device with near-infrared (NIR) light source, by which a database for finger vein images is established. Then they do pre-processing of the image in which they segment the shape of finger by using gradient operator to detect the vertical lines as finger edge then they use size and brightness normalization for feature extraction and final matching. They normalize the size by linear interpolation. Furthermore, finger vein LDC is proposed and performed, which creates a structured feature image for each finger vein. In LDC the vein valley characteristics is analysed in which it is considered that the point has high probability of being in the vein area when it is in the valley. By using this concept the vein location is extracted in which the two threshold values are considered according to which the vein location is measured. After this the local threshold method is used to further segmentation of the ambiguous pixels by finding mean and deviation of neighbouring pixel. After segmentation the median filter is used to smoothen the image by removing the noise. After smoothening the vein location and direction coding is done in which the overlapping of the direction map onto the binary vein location map yield the vein feature map with direction information. Finally, the structured feature image is utilized to conduct the personal identification on our image database for finger vein by calculating the total no. of matched points which includes 440 vein images from 220 different fingers. The equal error rate of our method for this database is 0.44%.

A paper published by Du Ge-guo[4] presents a kind of liveliness detection method based on an optical measurement for sequence infrared images. The vein images are related with vital signs such as oxygen saturation in human blood and heart rate. Two kinds of different algorithm are used for feature extraction, one for vital signs detection, the other for identification. In the algorithm the feature-similarity degree threshold are defined as p1 and p2. If the feature-similarity degree p of two images from continuous sampling is great than p1, the two images are marked sameness. If p is less than p2, the two images are marked independence. This method can prevent the identification spoofing and improve the security capability of vein identification system. Applying the above stated algorithm, an improved system can be easily built up that fake vein registration, rapid finger vibration; false blood fluidity cannot pass the examination.

The paper published by Daniel Hartung[5] a new approach is purposed which is based on Spectral Minutiae evaluation against other comparison strategies on three different datasets of wrist and palm vein samples. The first step is the pre-processing in which the contrast enhancement is done. In the purposed system the image first is enhanced by using adaptive non-local means after that noise suppression and edge enhancing nonlinear diffusion algorithm is performed. Now the vein of the hand appear as high intensity pixels, while tissue between the veins look as low intensity. Then the second step is segmentation in which the multi-scale filter is used for noise and background suppression. Third step is skeletonization in which the skeleton of the vein are extracted by the fast marching skeletonization algorithm which is based on the value of threshold in which the pixel value which is less than threshold is deleted and left with the remaining points. And then finally the features are extracted by the convolution approach in which the binary images are convoluted against the filter to get the unique responses and the end and branch points are found finally. After that the two type of matching strategy is done first is the direct matching in which the similarity score is calculated by the SML correlation and the second method is fast rotating shift searching. In this paper various comparison strategies are also

taken to measure the Equal Error Rate. For this experiment the three databases are taken SFIR, SNIR and UC3M. The comparison strategies used in the simulations, those are: Hausdorff distance, Modified Hausdorff (MHD). Similarity-based Mix-matching (SMM) and the proposed SML correlation (SMLC) as well as the SML fast rotate (SMLFR) strategy. SMM approach, that works on the skeleton and image level, can outperform the proposed solution. It shows a competitive biometric performance while producing features that are compatible with state-of-the-art template protection systems.

A paper by Sheetal, Ravi Parkash Goela, [6] said that a captured image from any kind of sensing element must be processed before the extraction of features. An image processing approach for vein pattern. The paper includes of filtering techniques, contrast enhancement strategies and segmentation processes. During this work, three different image filtering methods are used for the two different noise types to remove noise from the image. He presents image enhancement and image segmentation operations and there result when applied on multispectral vein image. The noise removal and segmentation operations are much helpful to extract the vein pattern as features.

A paper by Sujata Kulkarni, Dr.R.D.Raut[7] proposed a recent authentication system using finger vein. The vein pattern present beneath the skin of finger is distinctive and stable. It can be used for personal authentication that provides high security and reliability because of its positive characteristics over the others biometrics modalities. Explores the IR based finger vein capturing device and different algorithm for feature extraction of finger vein used for authentication. The paper highlighted the finger-vein framework, its recognition performance parameter i.e. false acceptance rate (FAR) and false rejection rate (FRR). The characteristics of finger vein authentication shows that it is more secure than the other correlated modalities.

A paper by Kang Ryoung Park[8] proposed new algorithms for finger vein recognition. This research presents the following three advantages and contributions compared to previous works. First, they ex-tracted local information of the finger veins based on a LBP (Local Binary Pattern) without segmenting accurate finger vein regions. Second, the global information of the finger veins based on Wavelet transform was extracted. Third, two score values by the LBP and Wavelet transform were combined by the SVM (Support Vector Machine). As experimental results, the EER (Equal Error Rate) was 0.011% and the total processing time was 98.2ms.

A paper by P. Gopinath[9] stated that Finger vein is an important biometric technique for personal identification and authentication. The finger vein is a blood vassal network under the finger skin. The network pattern is distinct for each individual, unaffected by aging and it is internal. i.e, inside human skin which can always guarantee more security authentication. In this proposing study to an analysis of different techniques for Finger vein feature extraction. The basic and important principle, different feature extraction techniques and performance measuring are briefly analyzed. Most of the existing work is functionally described and compared in three parts, i.e. Finger vein image acquisition, pre-processing and feature extraction.

A paper published by Mona A. Ahmed, et.al on ”Analysis of Palm Vein Pattern Recognition Algorithms and Systems”[10] in which they presents an analysis of palm vein pattern recognition algorithms, techniques, methodologies and systems. It discusses the technical aspects of recent approaches for the following processes; detection of region of interest (ROI), segment of palm vein pattern, feature extraction, and matching.

A paper published by Andrew Teoh Beng Jin, et.al; on “ Design and Implementation of a Contactless Palm Print and Palm Vein Sensor”[11] in which the purposed a approach Local Ridge Enhancement for image enhancement which remove the illumination error and one more approach known as Directional Coding to encode the palm print and palm vein features in bit representation.

3. Proposed Work

A Vein Recognition System is used to recognize the veins of human finger for any authorized access. In the purposed system numbers of steps have been taken to reach recognition point. First step is preprocessing in which median filter is used to remove the noise present in an image. Secondly ROI is extracted to reduce computational complexity. In third step Features are extracted from the finger image using region growing technique in which shortest distance is used as a criterion. Then minutiae are calculated or marked and may be joined to form curves. By these curves a radian is measured and it will be changed to angle by multiplying to $180/\pi$ after that they will be compared and finally, Fuzzy-Neuro Technique is applied for recognition.

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Finger vein is an unique and popular biometric identity. It is in use at various real life application like restricted entry points, lockers, etc. To obtain finger vein, a finger vein biometric device is required, on what human place his/her hand, and the device results the image of finger vein. Here,

the finger vein recognition algorithm reads the finger vein image obtained by finger vein scanning device to accomplish the image acquisition task. Finger vein image may carry some kind of noise caused by camera, weather, or other external stimuli e.g. Salt and pepper noise. Hence, finger vein image is required to pre- processed to remove the noise to produce reliable results. At this step, after the finger vein is obtained, the noise removal would be performed using median filter. The median filter is applied to remove the noise, hence will improve the finger vein image quality. The median filter is a non-linear digital filtering technique, often used to remove the noise. The median filter runs through part by part of an image and replaces each entry with the median of neighboring values. After removing the noise, the next step will consist of extracting the Region of Interest (ROI) because the image obtained by finger vein imaging/scanning device obtains the sample of whole human hand. The finger vein matching algorithm has to work with finger area of the hand only, so there is need to extract the region of interest from the sampled image. Then the ROI would be extracted using a unique algorithm, which detects the boundaries of the image, mark the internal objects, obtain the x and y co-ordinates, and the extract the desired region of interest from the target image. ROI algorithm will use a binaries image to perform the boundary detection. After finishing with finding the boundaries of the hand object, it will make logical difference between fingers and finger shapes. Then compute x and y coordinates for of the finger region, then re-adjust the (x1, y1) and (x2, y2) coordinates accordingly. Finally, it will result the sub-image of hand carrying the finger vein region for the further processing. Afterwards, the image enhancement techniques would be used to create a prominent finger vein for the fault tolerance and, reliable and accurate results. Firstly, the region growing technique will be used to enhance the image. Region growing utilizes Euclidean distance method to extract the features by enhancing the finger vein sub image. In math's, the Euclidean distance is the normal distance between the two points that can be measured with a ruler and is given by the Pythagorean formula. Using this formula, Euclidean space becomes the Euclidean matrix. The horizontal and vertical distance between the points is measured. With this small addition we get a right-angled geometric shape with its legs or co-ordinates. Then using a Pythagorean Theorem, the square of hypotenuse is performed, which results the length of hypotenuse. This result is same as the distance between the two points according to the distance formula. Region growing is a popular image segmentation method. Region growing segment the image on the basis of region. It is also called a pixel-based image segmentation method because it uses the selection of the seed points and can be also used for image enhancement. The major goal of region growing segmentation is to partition the image into region based on the pixel properties. Region growing algorithm will produce the better results and separate the regions with the same properties as per the defined ones. Then the light effect would be neutralized to clear the finger vein object more prominent for the feature matching process.

After getting the image, the intersections or minutiae points are marked. These minutiae points are joined with the imaginary curves. These imaginary curves are formed by joining the minutiae points. These curves are then calculated by the (0, 0) coordinates and these coordinates will calculate the radian. The radian is then multiple by 180/π. We get an angle by multiplying by this of the radian.

The curvature points refer to the angles or curves of the finger vein pattern, hence help to create an accurate template matching technique. As the number of curvature increase, it produces more accurate results.

Then it comes to the feature matching using Fuzzy-Neuro hybrid method, which combines fuzzy logic and neural networks for the feature matching. Fuzzy logic is used to compute a threshold value based on the image features calculated as the curvature points using the minutiae method, which will apply the minimum matching criteria on the training samples. Fuzzy logic will shortlist and return the training set entities according to the minimum matching criteria, which will be further processed using feed forward neural network. Image feature calculation will return the image features in the form of curvature points, which are at first evaluated using fuzzy and then neural network. The fuzzy logic will process the image with the different sensitivity matrix on the basis of quality threshold value (image features), before applying the feed forward neural network.

Neural network is the method used for feature matching with the training database. The trained database contains the feature sets of the particular users which were obtained on the time of registration. Neural network will return a percentage value after matching the test image with the training database. This percentage value is called sensitivity. The result will be returned after applying the hybrid decision logic, which contains fuzzy logic and neural network done to finalize the result.

4. Conclusion

In this research, the research model for the finger vein extraction has been designed and developed. The proposed model has been developed using the combination of minutiae point extraction along with deep curve analysis has been used in the proposed model. The deep curve analysis is based upon various properties of the curve such as curve length, its phase and amplitude. The curve length is computed on the basis of pixel distance between the two edges of the curve. The angle or phase has been calculated between the horizon point of (0, 0) and the center coordinates of the curve. The angle calculation has been completed in two steps. The first step computes the radian value between the horizon point and the center coordinate of the curve, which has been further converted to angle by multiplying it with 180/π. The accuracy around 94% has been achieved using the proposed model and the specificity/recall at 93.50% has been achieved from the proposed model. The very less equal error rate has been recorded from the proposed model results at 0.005. The proposed model has performed better in all contexts from the previous models.

In the future, the proposed model can be enhanced using different methods for extracting the minutiae points or vein curves or imaginary curves between the minutiae points. The proposed model can be compared with the other existing

models in order to analyse its performance on the basis of several parameters.

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