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Biometric Authentication by Dorsal Hand Vein Pattern

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ABSTRACT

Vein pattern is the network of blood vessels beneath a person's skin. This vein pattern can be used to authenticate the identity of an individual. In this paper, a new approach is proposed to extract features from the dorsal hand vein pattern. The length of the main vein and the angle at the bifurcation points were used as the key features for this system. We mainly used the concepts of hough transform and K-nearest neighbor matching algorithm. The proposed methodology has been tested on a self generated dataset of 20 persons dorsal hand vein images and the achieved experimental results are found to be promising, with an accuracy of 90%.

Keywords: *Hand vein, Hough Transform,Knn matching*

1. INTRODUCTION

There are great changes happened in the human society following the advent of the information age. People's dependence and requirement on information are enhanced day by day. Security in many situations is paid attention because of increase of crime with high technology. Security has been important in the view of privacy protection and information safety. Biometric individual authentication is used in many fields as an approach for security**.** As biometric authentication, there are methods using fingerprint, ins, vein pattern**,** voice and so on. At present, fingerprint recognition is comparatively a perfect identify authentication technology. The capability of fingerprint recognition algorithm has arrived at an applied degree. The price of it is comparatively lower than other feature extraction technologies. And it has been accepted by large customers. But, the fingerprint recognition is confronted with a bottle problem that the applicable people have been restricted largely. First people may lose the usable fingerprint suddenly. Sometimes the finger is too wet, dry or desquamated and such other characters dandification. As a result of that the fingerprint image may be dilapidated or blur, the possibility of successful matching may fall down, and big decrease in recognition rate. Although one does not have aversion for authentication with iris, many people dislike bringing the implement very close to eye. It seems that authentications with voice and so on do not have enough results for actual identification.

For these disadvantages of other biometric recognition methods, a new biology feature recognition technology - hand vein recognition technology has been studied in this paper.

Compared to other biometric authentication techniques, the vein recognition has many advantages as follow.

- The vein is the inner features of body, can't be fabricated.
- The vein recognition is contactless, don't contact with body of human and don't impinge on human body.
- The vein characteristics are lasting.

At present, the identity authentication technology based on hand vein recognition has been reported in some countries such as Japan, Korea, and China. The product of hand vein recognition has been born in some companies of Japan and Korea, China etc. But, Up to now, there isn't any hand vein recognition products coming out in India.
All biometric systems require each authorized user to be enrolled. This involves the user presenting the characterizing trait to the system one or more times. A library template or signature is then formed from this sample. This template may be stored in a database or encoded on a smart-card. Subsequently, when the user wishes to gain access, the characteristic trait must be presented to the system which then compares this against a single template in the case of a smartcard, or a multitude of templates.

Thus, this paper, based on hand vein recognition patterns, investigates the following points:

- On normal conditions gray scale discrimination of vein image is very small. If there is no good threshold, there is no possibility that we get the effective binary image which has enough information.
- The general conditional thinning can't achieve single pixel completely, this can bring us quite big trouble on the feature extracting based on endpoints and crossing points, so we must improve it further, here where hough transform comes into place.
- Finally for matching the features extracted stored in the database are to be matched using knn matching technique.

Anatomically, aside from surgical intervention, the shape of vascular patterns in the back of the hand is distinct from each other. Veins are found below the skin and cannot be seen with naked eyes. Its uniqueness, stability and immunity to forgery are attracting researchers. These feature makes it a more reliable biometric for personal identification. Furthermore, the state of skin, temperature and humidity has little effect on the vein image, unlike fingerprint and facial feature acquirement. The hand vein biometrics principle is non- invasive in nature where dorsal hand vein pattern are used to verify the identity of individuals. Vein pattern is also stable, that is, the shape of the vein remains unchanged even when human being grows.

Fig 1: The Exact place of hand vein extraction

In our case, we have acquired dataset samples using a simple camera under normal conditions of temperature and lighting. On normal conditions gray scale discrimination of vein image is very small. But since we have very good threshold segmentation methods and good thinning methods feature extraction was not a problem. The general conditional thinning can't achieve single pixel completely, this can bring us quite big trouble on the feature extracting based on endpoints and crossing points, so to improve this further we have used hough transform techniques.

Nowadays dorsal hand vein pattern biometric is gaining momentum. Extensive researches are carried out on vein patterns and researchers are striving hard to find methods and techniques to develop dorsal hand vein security system.

2. PROPOSED METHODOLOGY

The steps involved in the biometric authentication of dorsal hand vein are as given below:

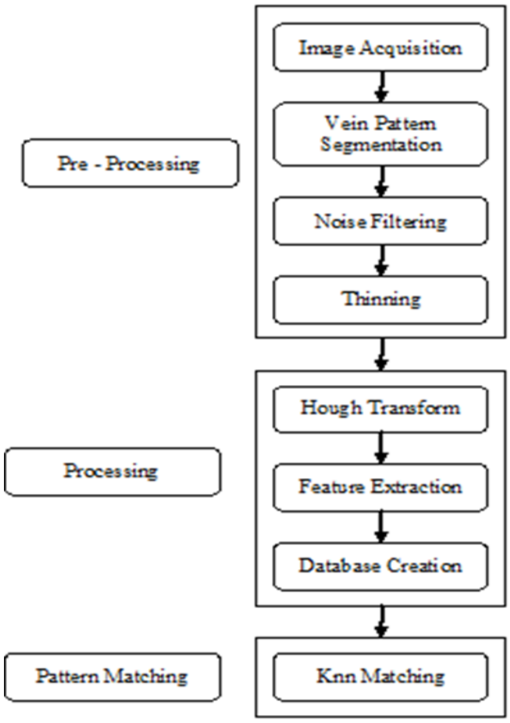

Fig 2: Biometric procedure

2.1 Pre-Processing

- *Image acquisition*: Firstly, the image is obtained from the our own dataset. The obtained image is given as the input image which is shown in figure 3.

- *Vein Pattern Segmentation*: A dynamic threshold based segmentation process is carried out which subdivides the image into its constituent regions. The vein patterns are extracted according to the threshold selected that gives segmented vein patterns which are as shown in figure 4.
- *Noise filtering:* To enhance the quality of vein patterns obtained, different filters was applied on these segmented vein patterns like Wiener filter which help in preserving edges and other high-frequency parts of an image and suppresses the noises that exist in vein pattern, Median filter which could reduce salt and pepper noise, eliminates blurs and make the borderline smooth. The filtered image is shown in figure 5.

- *Thinning:* Filtered vein image undergoes morphological operation which removes pixels on the boundaries of vein pattern but does not allow them to break apart. The pixels remaining make up the image skeleton. Thinning removes pixels so that vein pattern without holes shrinks to a minimally connected stroke, and the vein pattern with holes shrinks to a connected ring halfway between each hole and the outer boundary. The final image obtained after the pre-processing stage is thinned and skeletonized image which is as shown in figure 6.

Fig 3: Input hand vein image

Fig 4: Segmented vein

Fig 5: Filtered vein image

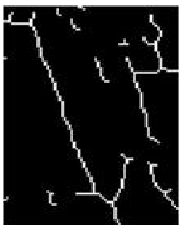

Fig 6: Thinned vein image

2.2 PROCESSING

The method used for processing the image and extracting the features is HOUGH TRANSFORM.

The Hough transform is a technique which is used to determine and isolate features of a particular shape within an image. It is most commonly used for the detection of simple curves such as lines, circles, and ellipses within a given image. The simplest case of Hough transform is the linear transform used for detecting straight lines. The classical Hough transform requires that the desired shapes be specified in some parametric form. Lines can be represented uniquely by two parameters say a and b as

$$y = a.x + b$$

But Hough Transform uses the form $r = x.\cos\theta + y.\sin\theta$ which can be rewritten as.

$$y = -(\cos\theta / \sin\theta).x + (r/\sin\theta)$$

The parameter θ and r is the angle of the line and distance from the line to the origin respectively. All lines can be represented in this form when $\theta \in [0,180]$ and $r \in \mathbf{R}$ (or $\theta \in [0,360]$ and $r >= 0$). For arbitrary point on the image plane with coordinates for example, (x0, y0) the lines that go through it are

$$r(\theta) = x0 . \cos\theta + y0 . \sin\theta$$

where r is determined by θ. This corresponds to sinusoidal curve in the (r, θ) plane, which is unique to that point.

Figure 7 image shows the hough lines detected:

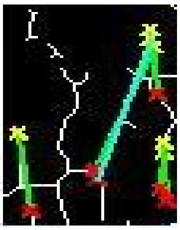

Fig 7: hough lines detected

The Hough Transform generates parameter space matrix whose rows and columns correspond to r and θ values respectively. The peak values in Hough space is detected, which represents potential lines in the input image and it also gives the endpoints of the line segments corresponding to peaks in the Hough transform and it automatically fills in small gaps. In our approach, we use the r and θ values and also find out the endpoints of the lines which help us in matching process.

2.3 Pattern Matching

The algorithm used to classify the datasets is **K Nearest Neighbor matching algorithm**

The intuition underlying Nearest Neighbor Classification is quite straightforward; examples are classified based on the class of their nearest neighbors. It is often useful to take more than one neighbor into account so the technique is more commonly referred to as k-Nearest Neighbor (k-NN) Classification where k nearest neighbors are used in determining the class.

The basic idea is as shown in Figure 8 which depicts a 3-Nearest Neighbor Classifier on a two-class problem in a two-dimensional feature space. In this example the decision for q1 is straightforward – all three of its nearest neighbors are of class O so it is classified as an O. The situation for q2 is a bit more complicated at it has two neighbors of class X and one of class O. This can be resolved by simple majority voting or by distance weighted voting

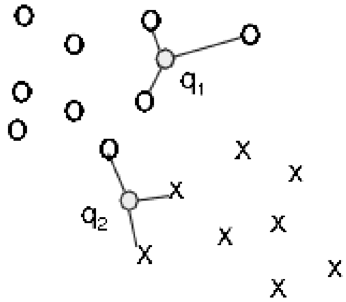

Fig 8: 3-Nearest Neighbor classification

So k−NN classification has two stages; the first is the determination of the nearest neighbors and the second is the determination of the class using those neighbors. Let us assume that we have a training dataset D made up of $(x_i)_i \in [1,|D|]$ training samples. The examples are described by a set of features F and any numeric features have been normalized to the range [0, 1]. Each training example is labeled with a class label $y_j \in Y$. Our objective is to classify an unknown example q. For each $x_i \in D$ we can calculate the distance between q and x_i as follows:

$$d(q, x_i) = \sum_{f \in F} w_f \, \delta(q_f, x_{if})$$

There are a large range of possibilities for this distance metric; a basic version for continuous and discrete attributes would be:

$$\delta(q_f, x_{if}) = \begin{cases} 0 & f \text{ discrete and } q_f = x_{if} \\ 1 & f \text{ discrete and } q_f \neq x_{if} \\ |q_f - x_{if}| & f \text{ continuous} \end{cases}$$

The k nearest neighbors are selected based on this distance metric. Then there are a variety of ways in which the k nearest neighbors can be used to determine the class of q. The most straightforward approach is to assign the majority class among the nearest neighbors to the query.

3. PROPOSED ALGORITHM

3.1 Training Phase

1) Image segmentation is done on human dorsal hand vein pattern image.

2) Filtering is done to remove the noise in the image.

3) Thinning of the image is done using skeletonization.

4) Hough transform is applied on the image and r and θ values along with end points of the lines are determined.

The above steps are performed for each image and the mean values of all the features obtained by Hough transform is computed for all the images in the dataset and this is stored in the database.

3.2 Testing Phase

1) The above steps 1 to 4 are repeated and the extracted features are stored in the database.

2) For classification we have made use of KNN classification

3) The final decision made by our system is based on the integration of the decisions made by the threshold fixed for the computed two features(r and θ) during matching

4. PROPOSED SYSTEM

The system was tested over a dataset consisting of 20 persons of different age and gender for each 3 left and 3 right hand images. In this proposed work, hand vein images are pre processed and hough transform is applied. The resulting features namely, r and θ are stored in the database, which becomes the training set.

The same procedure is applied for the query image to check for the authentication, based on the degree of similarities, all the images are ranked and top-n images are retrieved.

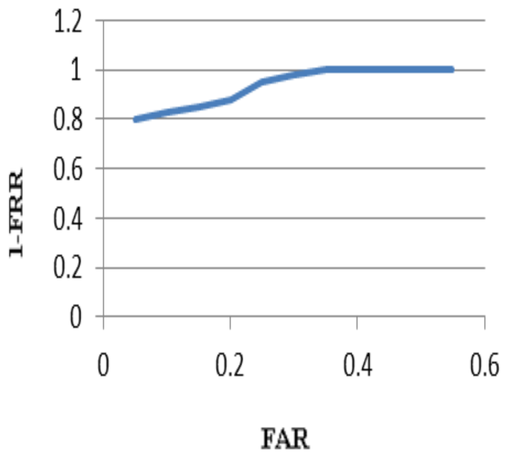

Fig 9: Plot of Receiver Operating Characteristics Curve

5. CONCLUSION

This paper deals with individual authentication using dorsal hand vein pattern. The Hough transform previously applied on dorsal hand geometry for feature extraction has successfully worked on vein images producing satisfactory results. It can detect lines and all arbitrary shapes. After feature extraction pattern matching is carried out using K-nearest neighbor algorithm. K-nearest neighbor algorithm is used to classify data into groups for faster matching. It works based on minimum distance from the query instance to the training samples to determine the K-nearest neighbors. After we gather K- nearest neighbors, we take simple majority of these K-nearest neighbors to be the result of the query instance.

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