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An Enhanced Palm Vein Recognition Using Chain Code

[1]DIVYA SINGLA, [2]Er. ALISHA

1Student,Haryana Engineering College

[2]Lect.,Haryana Engineering College

ABSTACT- Biometric Authentication system recognizes a person based on the physiological as well as behavioral traits. Palm vein structure pattern is unique for every human being even for the twins also. Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. Because the vein patterns of palm are inside the skin of a human being, they are a impossible to forge. Also, the system is non-intrusive (contactless) and unhygienic for use in public areas. It is more accurate than other biometric authentication such as face, iris, and retinal authentication system. In this paper we are using a maximum curvature point algorithm for feature extraction. In this actual filtering is done by constructing the filtering kernels and then estimating the centre position of their veins and their connection with central position. we are also using the concept of chain code used to represent the irregular lines of palm.

Keywords:- Palm vein, CASIA, Biometric , Authentication, Wavelength, Maximum curvature point, Ridges, convolution method .

INTRODUCTION

According to Fujitsu in the ubiquitous network society, any people can have easily access to their information anytime and anywhere, people are also facing the problem that others can easily access their information like password anytime and anywhere. Because of this problem, there is a need of personal authentication technology, which can distinguished between pre-registered legitimate users and forged user, is now generating interest.

Now a days, passwords, Personal Identification Numbers (4-digit PIN numbers) or identification cards are used for personal authentication. However, personal identification cards can be misplaced, forgotten or lost somewhere, and passwords and numbers can be forgot. To solve these problems, biometric identification technology, which identifies any person by their unique biological characteristics, is attracting people attention. According to Fujitsu research centre of Japan, in any biometric authentication system any legitimate user body characteristics, behavior, traits or body part image are registered in a database and then compared with the characteristics or traits of the person who may try to access that account. Characteristics, traits or image of a body of a person are compared to check that if the access is by the same or legitimate person or registered user or not.

A biometric authentication system that uses personal information like Characteristics or traits of any person that must be checked in order to have access to the system purposes are

• Exclusivity - The same traits does not appear in two different people.

• Measurability - The traits can be measured with some technical or physical instruments.

• easy comparable - The characteristics, traits or body part images can be easily Captured and compared with minimal discomfort.

Vein Authentication

In this field, "vein authentication" which uses image recognition and optical technology to scan the normally invisible palm vein pattern, hand from back, fingers, etc. has the properties of being highly accurate and highly efficient to recognize, impersonation and other forged actions.

Palm vein authentication uses an infrared beam to penetrate in the users hand and scan veins as it is held over the sensor; the veins present within the palm of the user hand are visible as black lines in image. Palm vein authentication system has a highest level of efficiency due to the uniqueness and complexity of vein patterns of the palm. Because the palm vein patterns are present inside the human body, this is impossible to forge. Also, the system is contactless (non-intrusive) and non-hygienic for use in public areas [1]. The palm vein pattern is a unique and ideal part of the body for this technology; as their does not have hair which can be an obstacle for scanning the blood vessel pattern, and palm veins are very less susceptible to change in a skin color, as compared to finger or the back of a hand [2].

Principle for vascular pattern authentication

Infrared rays (IR) are electromagnetic radiation whose wavelength is longer than that of the visible light, and Infrared light has a range between 750nm and 1mm of wavelength, similar to visible light having wavelengths ranging from red light to violet. Infrared light is commonly divided into 3 spectral regions:

(a)Near infrared light

(b)Mid infrared light

(c)Far infrared light

but the boundaries ranges are very closer to each other thus difficult to separate. [3].

Vein patterns of body or palm cannot be seen using normal, visible rays of light since they are inside the skin's surface. There are two choices of focusing on imaging or scanning of vein patterns in the palm by the infrared light

1. The far-infrared (FIR) imaging
2. The near-infrared (NIR) imaging

These light rays are suitable to capture images of human parts in a non-hygienic way [4].

Acc to fujitsu of Japan the hemoglobin contained in the blood is oxygenated in the lungs of the human and delivers oxygen to all the tissues present under the body through arteries. After that it delivers or releases the oxygen it carries to all the tissues that are present inside the body, the part of blood that contain the deoxidized hemoglobin blood go back to the heart through the veins present in the body. There is different level of absorbency of light by the hemoglobin present in the blood. Deoxidized hemoglobin present in veins or travels through veins absorbs light at a wavelength of about 760 nm in the near-infrared region or short wavelength region. When the palm area of human hand is illuminated with this near infrared light rays ,the vein pattern of human body cannot be seen by the naked human eye [Figure 1(a)],as the deoxidized hemoglobin in the veins absorbs this near infrared light of short wavelength , thereby minimizing the rate of reflection of light and causing the veins to appear as a black pattern in image [Figure 1(b)]. The vein authentication system are based on this principle that, the region used for authentication is scanned and photographed with short wavelength rays or near-infrared light rays, and the vein pattern of palm is extracted by image processing techniques [Figure 1(c)] and the extracted image gets registered in the system. The vein pattern of the person being wanted to access the system is then verified against the preregistered legitimate user palm veins pattern.

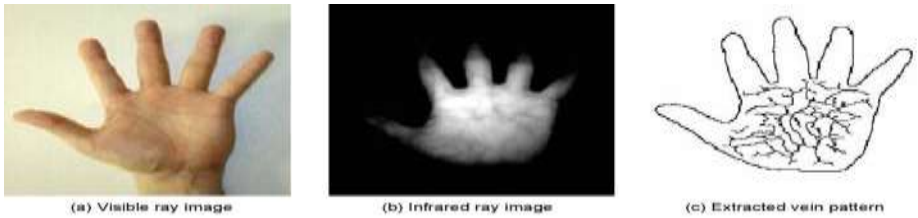

Figure1: Extracting palm vein pattern

The still image of hand captured by the camera, which takes the image of palm in the near-infrared light, thus causing the veins to appear as a black network in the image, thus reflecting or highlighting the palm's vein pattern against the lighter background of the palm.

An individual's palm vein image is converted by algorithms into matrix of data points, and then compressed using various techniques, encrypted, and stored in the software and gets registered along with other details in his profile as a template for future reference. Thus, every time a person wants access his account by a palm authentication system in a securely manner, the person palm newly captured image taken by camera is again processed by certain algorithms and compared with the registered one for verification, just in a few micro seconds. Direction, Numbers, orientation, length and the positions of veins and their crossing points are all evaluated and compared with the registered image, depending on the verification result, the person is either granted or denied access to the system.

Palm vein authentication consideration reason:

1. Vein patterns are unique to each individual; even identical twins have different vein patterns.
2. The palm has no hair; it is easier to photograph its vascular pattern.
3. **Secure:-** It is difficult to forge for intruders because blood vessels are hidden within the body.
4. **Non-Intrusive:-** It does not involve any physical contact between the user and the system.
5. Palms have a broad and complicated vascular pattern and thus contain a significant amount of differentiating features for personal biometric identification.

Related Work:

A lot of research showing the usefulness and exclusiveness of palm vein authentication system has appeared in the literature.

Palm vein model

Palm vein technology works by identifying the unique vein patterns in an individual's hand. When a user's palm is held under a scanner, a near-infrared light finds the location of the veins. The red blood cells or deoxidized hemoglobin of blood present in the veins absorb the light and reflection rate of light is less ,thus veins are visible as black lines, whereas the remaining structure of palm is visible as white. This vein pattern is then verified with a pre-registered legitimate user pattern to authenticate the person to the access. As veins are under the skin of the body and have a millions of differentiating traits, attempts to forge an identity are extremely difficult or merely impossible, thereby enabling a high level of security [5].

Steps involved in palm vein authentication system are:

1. Image Acquisition

The CASIA database that contains 7200 multi spectral palm images is considered as base of palm vein images. The image is verified using image of palm take from CASIA database as reference. The multispectral palm print contains information about veins location and size.

2. ROI Selection

ROI segmentation of palm vein is to automatically and reliably segment a small region from the captured palm vein image and palm vein extraction is to extract the palm vein from a ROI. This is considered one of most important stages in these four stages because it greatly influences the overall identification accuracy and processing speed of the whole system [9].

Kai-Wen Chuang et.al In this paper, the author presented a palm vein ROI extraction algorithm which combines

1. Otsu thresholding scheme,
2. Morphological opening operation
3. Sobel edge detector
4. Reference points
5. Line construction
6. Palm vein image alignment.

The performance of the proposed palm vein ROI segmentation scheme is verified using a palm vein image database, Poly U database (version 2). The experimental results show that the proposed algorithm is effective and efficient in palm vein ROI segmentation and is robust for noises surrounding palm vein images [9].

Yingbo Zhou et. al in this paper presented a palm vein ROI extraction technique:

The acquired palm vein images are firstly normalized to minimize the rotational changes in the image, translational changes and scale changes.

1.The co-ordinate system is constructed through those variations.

2. The web between index finger and middle finger together with the web between ring finger and little finger were utilized as the reference points line to build up the coordinate system (figure 2).

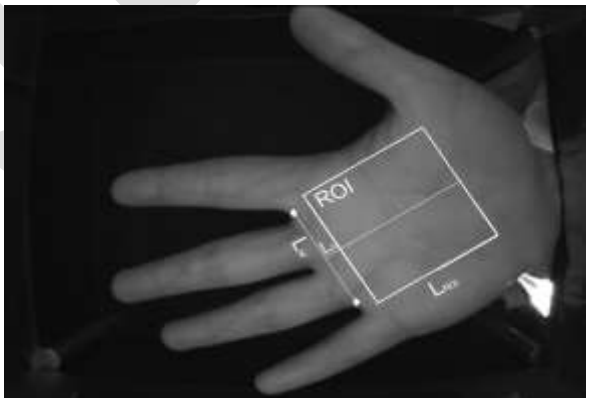

Figure 2: Palm vein ROI from contactless images

3. The location as well as the size of region of interest (ROI) is selected based on the distance between the two webs (*LW*) [10].

3 . Vein Pattern Extraction

Yingbo Zhou et.al in this paper investigates new approaches, for extracting different kinds of palm vein features and illustrate good performance. **The localized Radon transform** based approach achieves best performance and also offers computationally simpler alternative to existing palm vein identification approaches. The idea of local random transform approach is that curved and straight lines can be estimated by small piecewise joint integrated segments and it integrates the intensity value in the local region in all well defined orientations, but instead of integrating all the pixel values inside the local region, only the pixel that fall in the defined or confined line width area is integrated, and the orientation at that local region thus gives the minimum or maximum integration value [10].

Mohit Soni et. al researcher presents a technique which extracts the forking from the skeleton image by examining the local neighborhood of each ridge pixel by using a 3X3 matrix window. It can be seen that the processed image is that an ROI contains some thinned lines or also called as thinned ridges. These ridges/lines are representing vein patterns can be used to extract features. Features like ridge/line forking are determined by computing the number of arms originating from a pixel point. This can be represented as matrix *A*. A given pixel P at some point is termed as a ridge forking for a vein pattern if the value of A for the pixel is more than 3. This ridge forking pixel is considered as a feature point which can be defined by (x, y, θ) where x and y are the coordinates and θ is the orientation with respect to a reference point [11].

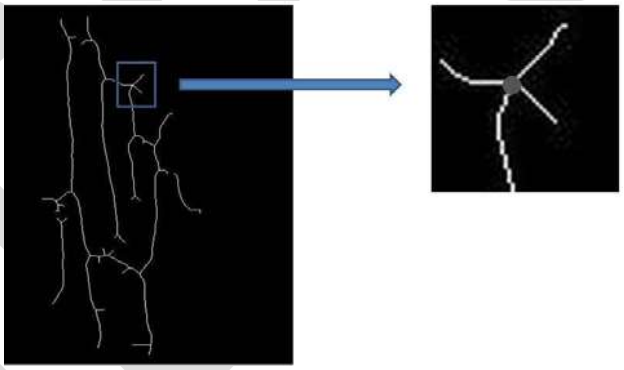

Figure 3: Four Arms emitting from a forking point

4. Skeletonization

As human beings grow the size of veins in body of human also grow, only the shape of the vein pattern is same, thus is used as the sole feature to recognize each person. A good representation of the vein pattern's shape is via extracting its structure or skeleton. Figure 4 shows the structure of the vein pattern after applying the thinning algorithm proposed by Zhang and Suen [12] . It can be seen that after the pruning process, the skeletons of the vein pattern are successfully extracted and the shape of the vein pattern is well preserved [6].

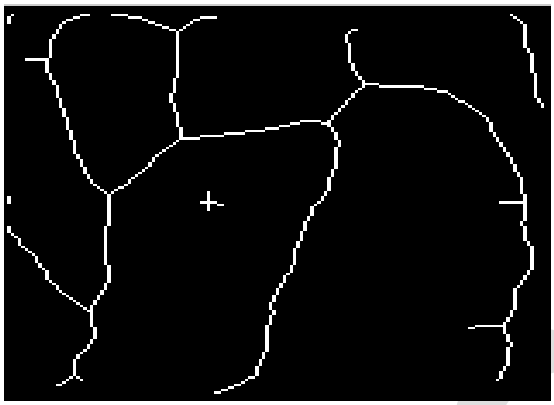

Figure 4: After Skeletonization

5. Vein Pattern Matching

Sunita Aeri et.al proposed a new approach for biometric authentication system using infrared thermal hand vein patterns. The author proposed work presents a Euclidean distance based vein's pattern biometric authentication that can be used for matching the biometric identity of person under scanner. The vein patterns are taken using the infra red (IR) thermal cameras and after applying some image pre-processing techniques, a binary image is obtained containing of veins crossings and
intersections. The binary image is thinned using the morphological operations and a single line thinned image pattern is obtained. The thinned image pattern is now examined for intersections extractions and inter-distance between intersections. The inter-distance among crossing points of vein patterns is stored in a data base. Further, when a newly taken vein pattern is brought under test, the information contained in the data base is compared to that of the newly taken test pattern using Euclidean distances. If the Euclidean distance is less, the test pattern is more equivalent to the database pattern [13].

Lingyu Wang et.al Vein pattern matching is done by measuring the Hausdorff distance of line segment and Hausdorff distance between a pair of vein patterns. Hausdorff distance is a natural measure used for comparing similarity of shapes. It is based on distance measured between two point sets of two different veins patterns. Hausdorff distance method uses the spatial information of an image, but lacks the structure representation such as orientation when it comes to comparing the shapes of two curves. To overcome this weakness, in this paper, the author presents the line segment Hausdorff distance (LHD) that is used to match the shapes of vein patterns. It incorporates the structural and spatial information of line segment orientation and line-point association, and hence is effective to compare two shapes made up of a number of curve segments [6].

Proposed work

Palm vein authentication system will consist of the following steps:

- Preprocessing
- Feature extraction
- Matching and verification

In preprocessing we processed the image using various preprocessing techniques in order to make it more suitable for feature extraction. The preprocessing steps include segmentation and enhancement.

The block diagram of proposed methodology is given in the figure below:-

Segmentation:-

This will involve segmenting the palm area which contains the desired information from the input image. This will be a particular area of the palm containing the palm veins and principle lines of our interest.

Feature Extraction:-

When the image has been normalized and oriented properly then feature to be used for authentication and matching have to be extracted. We will be using various filters for separating noise and then a technique is used for feature extraction.

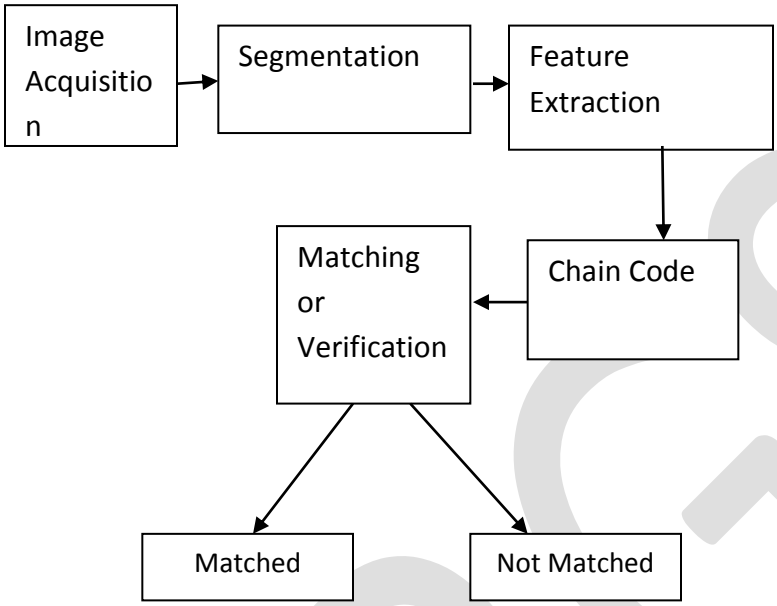

Figure 5: Proposed Methodology

Chain code:-

After extracting the features to avoid the losing details of the palm line structure, these irregular lines are represented by chain code.

Matching:-

To match the palm lines, a matching score is defined between two palm prints according to the points of their palm lines.

Implementation

1. segmentation
Local Neighborhood Thresholding

The local neighborhood thresholding is a simple and computational efficient process for segmenting the palm images, in contrast to the other segmentation technique known as global thresholding Otsu's method [Otsu (1979)] which proved inadequate in our experiments.

In every pixel position, a $N * N$ square window of pixels, containing also the neighboring pixels position value is considered (the testing pixel is at the middle of the taken N * N window), and the average or mean value of the pixels brightness value inside the

window is estimated. If the brightness of the pixel at central position is more than that of the corresponding pixels mean value position in that window, than that pixel is viewed as vein; otherwise it is to be considered as a tissue, as shown in the Fig 6. The palm window size affects correspondingly the quality of the produced binary segmented image, and the most accurate or appropriate window size is selected experimentally [15].

Figure 6: Segmented image of palm

2. Feature Extraction

For extracting the veins from the multi spectral palm image, we have chosen a maximum curvature point algorithm; this algorithm checks the curvature of the image profiles and emphasizing only on the palm veins centerlines. The central position of palm veins are detected by tracking for positions and directions where the curvatures of a cross-sectional (meeting point) profile of a vein image at locally maximal points. Our algorithm of detecting the features in a person palm is independent against temporary fluctuations in size of vein, their width and brightness. The cross-sectional positions are connected with each other, and finally the principal lines and vein pattern is obtained using maximum curvature algorithm [14].

The algorithm consists of

1. Constructing the filtering kernels.
2. Do the actual filtering of image.
3. Estimating the Center position of veins.
4. Connection of center positions.

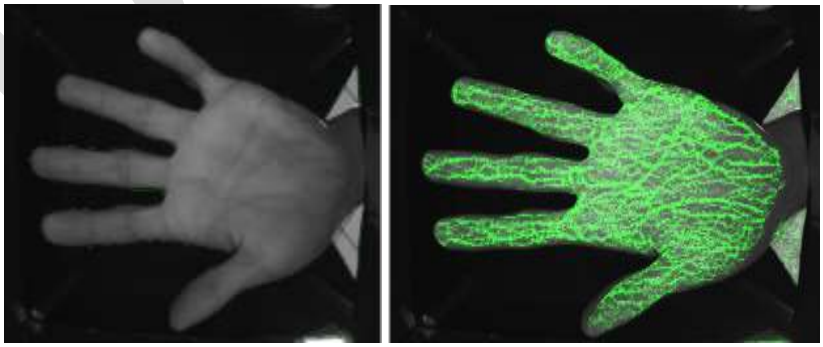

Fig 7(a): Curvature marking of image

7(b): Vein Extracted from palm vein image

3. Chain Code

It is a way of representing the irregular palm lines present in the palm. The irregular lines are represented in the form of matrix. Tracing the chain code provides local ridge directions at each boundary pixel. We divide the image into N * N blocks and use the ridge detections.

The algorithm is as follows.

(a) Use the width of veins as a guide to estimate the threshold under which components are likely to be noise.

(b) End points are detected (Section c) and not made part of the computation of the direction flow field as directions around end points tend to be ambiguous.

(c) The orientation of ridge is computed using the four (left, right, up, down) chain code directions of contour points in each block.

A voting algorithm is used to select the dominant direction as the local orientation. The threshold used for filtering noise can be dynamically estimated from the average width of ridge sizes. The minimum number of contour points in a block to derive orientation is determined based on the block size and is about 30 in our experiments.

Breaking palm veins are traced throughout the width and height of the palm. The centre position of the palm vein is estimated and along the height or the width of the palm. It ends at the end point of the palm the it is regular otherwise it is irregular.

4. Matching

Matching is employed to determine the authenticity of an individual, or to verify that somebody is a not forging who he or she claims to be. To perform matching, the system takes image from the person and extracts the features and creates a template of it.

The template image contains both the palm vein and principle lines pattern. The template image is compared with the image of the person who wants to authenticate himself inside a system. For verification, the system can retrieve the features of a single person and perform a one-to-one comparison.

The matching is performed using convolution method. A matching score is given, which is between 0-0.5% showing whether the vein pattern of palm's is matched or not.

Conclusion

Biometric refers to automatic recognition of an individual based on her behavior or traits. However the palm vein authentication system uses the vein's patterns of one's palm for making access to the system. In this paper the feature from one's palm is extracted using a maximum curvature point algorithm. The template image thus formed contains the principal lines as well as the palm vein pattern that is to be verified with newly taken palm pattern using convolution method. This technology is highly secure because it uses information contained within the body and is also highly accurate because the pattern of veins in the palm is complex and unique to each individual. Moreover, its non-intrusive (contact-less) feature gives it a hygienic advantage over other biometric authentication technologies.

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