Vein Recognition

Jyoti Prakash Vengurlekar[1] Shital S. Mali[2]
[1, 2]Ramrao Adik Institute of Technology Nerul, Navi Mumbai

Abstract---Many biometric systems, such as face, fingerprint and iris have been studied extensively for personal verification and identification purposes. Biometric identification with vein patterns is a more recent approach that uses the vast network of blood vessels underneath a person's skin. These patterns in the hands are assumed to be unique to each individual and they do no change over time except in size. As veins are under the skin and have a wealth of differentiating features, an attempt to copy an identity is extremely difficult. These properties of uniqueness, stability and strong immunity to forgery of the vein patterns make it a potentially good biometric trait which offers greater security and reliable features for personal identification. For recognizing vein pattern we can make use of dorsal hand and palm print database. In this particular recognition we will make use dorsal hand database. As dorsal hand can give proper vein pattern and palm print gives compressed image of hand which cannot give proper vein pattern. The hand vein database has been collected under realistic conditions in that subjects had to undergo the procedures of holding a bag, pressing an elastic ball and cooling with ice, all exercises that force changes in the vein patterns. The proposed hand vein authentication system uses the near infrared imaging techniques. Captured images will be processed before matching for noise suppression and data reduction. Vein recognition can be used in the personal authentication system. In this vein pattern of an individual is used to identify the person. As vein pattern is unique in individual. Normally it won't vary for long period of time. So that chances of data duplications are minimized whereas in fingerprint, iris and in face recognition it can be duplicated. To reduce the chances of duplication we can make use of vein pattern recognition.

I. INTRODUCTION

Associating an identity with an individual is called personal identification. The problem of resolving the identity of a person can be categorized into two types; verification and identification. Verification refers to the problem of confirming or denying a person's claimed identity. Identification refers to the problem of establishing a person's identity. Automatic human identification has become an important issue in today's information and Network-based society. The techniques for automatically identifying an individual based on his/her physiological or behavioral characteristics are called biometrics, which provides an answer to this need. Biometric techniques fall into two categories: physiological and behavioral categories. Common physiological biometrics includes face, eye, finger, palm and geometry, back of the hand vein pattern or thermal images. Behavioral biometrics includes voiceprints, handwritten signatures, and keystroke/signature dynamics. In recent years vein recognition is developing technique in the last decade. In this vein pattern of an individual is used to identify the person. As vein pattern is unique in individual. Normally it won't vary for long period of time. So that chances of data duplications are minimized whereas in fingerprint, iris and in face recognition it can be duplicated. Hence to reduce the chances of duplication we can make use of vein pattern recognition. The main biometric features can be listed as:

- Uniqueness and permanence of the pattern
- Non-contact detection procedure
- Almost impossible to forge or copy.
- The biometric parameter is hidden from general view
- The vein pattern is intricate enough to allow sufficient criteria for positively detecting various subjects' even identical twins.

Here we are using dorsal hand database for recognition. As dorsal hand can give proper vein pattern whereas palm print gives compressed image of hand which cannot give proper vein pattern. Shape of the subcutaneous vascular tree of the back of the hand contains information that is capable of authenticating the identity of an individual to a reasonable accuracy for automatic personal authentication purposes. The infrared region is of special advantage since the skin tissue is relatively transparent and the blood absorbs infrared light well. Hence, the veins background contrast is higher than the visible area. Used database is captured in NIR region with CCD camera. Then pre-processing is performed; this pre- processed image is used for feature extraction. There are many research attempts for the extraction, segmentation and tracing of subcutaneous peripheral venous patterns, its main aim is to make data reduction and noise suppression for good diagnostic purposes and for making some quantitative measurements like lengths and diameters for the extracted vessel segments. Researchers in hand vein biometrics [8] had a satisfactory result for either verification or identification purposes, regardless of the difference in datasets size, methods, or vein similarities used [7].

II. LITERATURE SURVEY

Nowadays a very large number of identification systems exist that are based on different types of biometrics. This includes iris, fingerprint, retina, voice, face, palm and vascular pattern recognition (VPR). VPR is new emerging technology in the biometric field, and has been gradually adopted over the world. The idea of using the hand vascular pattern as a biometric was first considered in the early 1990s but it wasn't until 1997 that a commercial product was developed. In 2000 it finally became popular when an application was created for personal identification based on the vein pattern on the back of the hand. Since its introduction, hand vein pattern technology has expanded to fingers and palm based systems and was adopted in 2007 by the International Standard Organization (ISO) where the storage and transmission of vascular biometric images was standardized. The demand for secure identification systems has increased exponentially over the last ten years. These systems are required to be very reliable but also easy to use since their application is no longer restricted to high-security facilities. The advantages of hand vein pattern recognition are due to the fact that veins lie underneath the skin, which makes them easily accessible for the system but also hard to alter. The market for hand VPR technology is growing rapidly and today it is an area of ongoing research that draws a lot of attention [3].

In recent year several biometric systems have emerged and several verification technologies utilizing vein biometric features had been developed. Xi Li, Xiangbin Liu, Zhicheng Liu used bilinear transformation and moment invariant method. In this database is resized first using bilinear transformation. Because of illumination gathering it produces gray vein images, gray normalization is used. Then local dynamic thresholding is used to find pixels' mean n variance gray which is nothing but segmentation. Boundary of vein pattern is not so smooth. Hence smoothing is performed but it is before thinning. As direct thinning will result in spurs. Median filter is used for smoothing. Then it is followed by thinning n pruning. Pruning removes spurs which are existing in thinned images. End point n intersection points are used to trim the vein pattern. Later seven moment invariants is defined based on normalized central moment. Compared with other moments, the seven moment invariants are better for the invariance property with regard to translation, rotation and scale. So they are more suitable for being used as the feature of recognition and classification. But the recognition result is not so good when they are used as the feature directly for their values varying widely [11].

Goh Kah Ong Michael and Tee Connie, Andrew Teoh Beng Jin used wavelet transform and sobel operator to extract features. In this directional coding method is used to extract palm vein features. The tests carried out in this study could not adequately reflect complete habituation of the biometric system due to the limited testing period (only 8 weeks). So need to conduct comprehensive investigation for complete habituation in future research. [12].

Amioy Kumar M. Hanmandlu Vamsi K. Madasu Brian C. Lovell used Box and branch point based approaches for multiple feature extractions. Region of interest (ROI) was extracted from the vein patterns were convolved with Gabor filter. Debnath Bhattacharyya, Poulami Das, Tai-hoon Kim, Samir Kumar Bandyopadhyay proposed Pattern Marker Algorithm (VPMA), Vascular Pattern Extractor Algorithm (VPEA), and Vascular Pattern Thinning Algorithm (VPTA). Maleika, Naushad and Raja applied Principle Component Analysis (PCA), with Cholesky decomposition and Lanczos algorithm to extract the vein features which decreases the number of computation and the processing time. Mohit Soni, Sandesh Gupta, M.S. Rao, Phalguni Gupta applied Euclidean Distance based matching technique for making the decision for feature extraction. Yuan, Lu and Yahagi proposed a certification system that compares vein images for low-cost, high speed and high-precision certification [10]. But their algorithm could not effectively extract the vein pattern from input hand images.

III. PROPOSED METHOD

The proposed hand vein biometric identification system consists of four main processing stages: (i) image acquisition, (ii) image preprocessing (iii) feature extraction (iv) Matching and identity detection; as shown in fig.1. The entire system can be divided into four steps: data collection, preprocessing, feature extraction and feature matching [1].

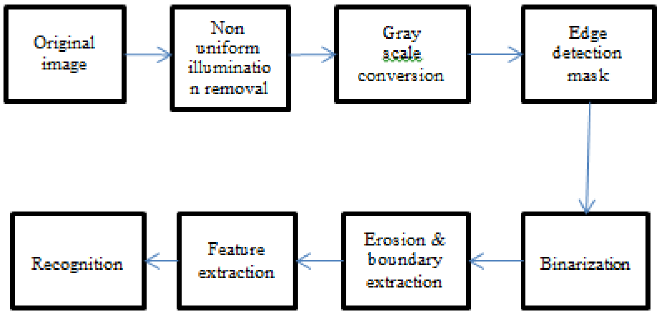

Fig. 1: Biometric identification system

A. Image acquisition:

As veins are internal, their structure cannot be discerned in visible light. Based on the kinds of light of acquisition, a vein image can be classified as X-ray scanning, ultrasonic scanning and infrared scanning. X-ray and ultrasonic are used to capture vein images in medical treatment, but they are not used in identification due to the health case. Until now, researchers used infrared imaging for personal identification. Infrared (IR) is electromagnetic radiation whose wavelength is longer than that of visible light, and Infrared light has a range of wavelengths lies between about 750nm and 1mm, just like visible light has wavelengths that range from red light to violet. Infrared is commonly divided into 3 spectral regions: near, mid and far-infrared light, but the boundaries between them are not agreed upon [5].

1) FIR images:

The temperature of surface of human veins is higher than that of the surrounding parts. Therefore when the FIR light irradiates hand, the hand vein structure is thermally mapped by an infrared camera at room temperature. The captured image shows a gradient of temperature between surrounding tissues and the back-of-hand veins In literature, it is proved that the captured FIR image of the back of hand has good quality, which means containing more useful information, but FIR vein image at palm and wrist have poor quality. Whilst this method deeply affects by the humidity and temperature of surrounding, as well as the users' perspiration does.

2) NIR images:

Near infrared wavelength is between about 700 nm to 1400 nm. The veins appear darker in an image taken by a CCD camera. NIR method is not a temperature based technique since normal body temperature or surrounding temperature cannot interfere with this method. In order to benefit the processing, the captured images are always the grayscale image [5]. In visible light, the vein structure on the back of the hand is not easily discernible [7]. The database which we are using here is having left hand images in different conditions. The hand vein images are captured in different acting conditions; then after holding ice in hand, holding bag and one of the set is under normal condition. Here each set is having 300 images. The clarity of the extracted vein pattern varies from image to image, therefore the quality of these images need to be enhanced before further processing.

The extracted feature is then matched with the stored parameters to authenticate the user [1].

B. Hand Vein Image Pre- Processing:

Second step in the recognition is preprocessing. Infrared radiation does not penetrate all kinds of tissue in the same manner and therefore images taken from various subjects may vary significantly in terms of clarity of the vein model and in some severe cases the resulting image may have connectivity problems, several regions could be blurred or even impossible to detect. So various image processing algorithms are needed to extract the correct information from the captured images [1] which are shown in fig.1. In further sections we will discuss these steps in details.

a) Non Uniform Illumination Removal:

If the user's choice is comparison, some form of normalization should be done beforehand in order to provide „better" input for automated image processing and realize a robust system against fluctuation. Conventional pre-processing technique of contrast stretching which darkens pixels in between two pre-assigned ranges while retaining all other information is used for this purpose.

Contrast stretching (often called normalization) is a simple image enhancement technique that attempts to improve the contrast in an image by 'stretching' the range of intensity values it contains to span a desired range of values, e.g., the full range of pixel values that the image type concerned allows. It differs from the more sophisticated histogram equalization in that it can only apply a linear scaling function to the image pixel values. As a result the „enhancement" is less harsh. Most implementations accept a gray level image as input and produce another gray level image as output[16].

b) Contrast Stretching:

Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds. Contrast enhancements are typically performed as a contrast stretch followed by a tonal enhancement, although these could both be performed in one step. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, whereas tonal enhancements improve the brightness differences in the shadow (dark), mid tone (grays), or highlight (bright) regions at the expense of the brightness differences in the other regions[18].

c) Gray Scale Conversion:

The acquired images are not very clear in their vein pattern, so it requires enhancement of images. Therefore the vein images with low contrast and uneven illumination are subjected to nonlinear image enhancement. The acquired images are firstly divided into overlapping 30 × 30 pixels sub blocks and average gray level in each of the blocks is computed. This average gray level is then used to construct average background image[19].

d) Edge Detection Mask:

Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are the abrupt changes in the pixel intensity at the boundaries. The geometry of the operator determines a characteristic direction in which it is most sensitive to edges. Operators can be optimized to look for horizontal, vertical, or diagonal edges. The edge detection operators give information about the gradient of the edges. The various gradient operators used for edge detection are Roberts, Prewitt, Sobel, Canny, Laplace, FreiChen, and Kirsch. Here there is brief description of these masks. In this method we are using canny edge detection mask.

The Canny edge detector is widely used in computer vision to locate sharp intensity changes and find object boundaries in an image. The Canny edge detector first smoothes the image to eliminate any noise present. Then compute the gradient magnitude using approximation of partial derivatives, thin the edges by applying non-maxima suppression and finally detect edges by double thresholding.

Good detection & localization, clear response is the goals to get edge detected image. These goals are achieved by applying the method discussed above for edge detection. The goals are also the performance criteria for edge detection. Mask is

0	-1	0
-1	4	-1
0	-1	0

Gx

-1	0	-1
0	4	0
-1	0	-1

Gy

e) Binarization:

Binarization is the case of segmenting the image into two levels black and white. Here we can assign black and white level to the region of interest and background [7]. This binary image is used for applying transforms; which will extract the features from the required image.

f) Erosion:

Erosion is typically applied to binary image, but there are versions that work on gray scale image. Erosion of any image is done with the structuring element. It is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood.

An essential part of the erosion operations is the structuring element used to probe the input image. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood.

g) Boundary Extraction:

The extraction of boundary is done in order to get proper vein pattern. The extraction of boundary is done after erosion. The resultant image after subtracting the eroded image from the original image has the boundary of the objects extracted. The thickness of the boundary depends on the size of the structuring element.

h) Recognition:

Recognition of database images is done on the basis of MSE. It calculates mean square error between the fired image and database image. According to MSE value the images are sorted in the array. Then using indexing method the image with the minimum square is selected as output of the fired image.

C. Feature Extraction & Matching:

Because of the temperature, illumination, locus and angle vary each collection; the captured image varies each time. In order to provide 'better' input for queried image, the above mentioned preprocessing algorithms are applied. Then the vein patterns are extracted after noise reduction [5]. In statistics, we use moment to describe distribution of random variable. If we take the binary or gray image as the function on 2 dimensions density distribution, we can apply moment on describing the feature of an image[15]. Moment invariant approach is most suitable for recognition of pattern, alphabets, images[14]. The seven moment invariant method is for feature extraction. Hu has presented moment invarients in 1962, they are widely used in many applications. Subsequently, Resis revised and Li reviewed and re-formulated, also produced higher order invariants. However, increasing complexity with increasing order and having redundant information because of not being derived from a family of orthogonal functions are the two main drawbacks of Hu moment invariants.

IV. RESULTS

From the proposed method recognition rate is improved which is shown in following table 1. The results are compared with the Independent Component Analysis, Non –negative Matrix Factorization, Line Edge Map[3].

	ICA1	ICA2	NMF	LEM	PROPOSED METHOD
NORMAL	94.33	97.33	89.67	81.66	**98.67**
BAG	88.55	82.88	83.33	88.44	**99**

Table. 1: Results

V. CONCLUSION

Current electronic security systems, which rely primarily on passwords, personal identification numbers, and authentication tokens (smart cards) to ensure that a client is an authorized user of a system, all have a common vulnerability,: the verification can be lost, stolen, duplicated, or guessed. With the use of biometric technology, this vulnerability can be nearly eliminated. A vein print is extremely difficult to forge and therefore contributes to a high level of security; the opportunities to implement palm vein technology span a wide range of applications.

As we are using database of hand images under adverse conditions mirroring real life situations and developed a new flow of pre-processing steps which includes edge detection masking, segmentation, histogram equalization, thresholding, Binarization and feature extraction using discrete cosine transform, discrete wavelet transform algorithm to enhance the results of verification.

VI. FUTURE SCOPE

Future researchers will address several vein recognition related problems such as Contactless hand vein image acquisition, the registration and classification. Also the work can be done on extraction of local features of the image. The results can be obtained by Gabor filter, Local binary pattern or gradient variety. Also the results can be analyzed with the effects of time lapse on a more significant volume of subjects.

The future work includes comparison of left and right hand images under different conditions. The MSE can be used for determining the neighboring element and calculating the classification rate. An overall count of number of elements belonging to same category can be taken and average of it is the classification rate. Classification can be done on the basis of MSE of each image present in the database. KNN will give a high classification rate for the proposed system. In KNN classification is done by comparing feature vector at each instance.

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