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HAND VEIN BASED PERSONAL IDENTIFICATION SYSTEM

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ABSTRACT

Personal Identification is necessary and useful to prevent crime in our society. Biometric traits extracted from hand image are more secure to use for identification compared to Personal Identification Number (PIN) because these features cannot be stolen. Developing an effective hand vein based personal identification system using robust feature with appropriate classifier is a serious task. Therefore this work incorporates new hand vein feature and two different classifiers to develop a personal identification system. Experiments were carried-out to affirm appropriateness of Support Vector Machine (SVM) and Euclidean Distance Measure (EDM) for the proposed system. The results obtained show that the proposed system give better result using SVM compared to EDM.

KEYWORDS: Hand vein, Geometric features, Euclidean Distance Measure, Support Vector Machine.

INTRODUCTION

Hand image pattern is a physiological trait that can be easily acquired for different applications such as access control and for attendance purposes. Human hand has many parts; these includes fingers, palm and dorsal. Characteristic of human hand image can be defined using pattern generated from these parts. Vein vessel pattern presents at the back of the hand is called dorsal vein and it is a unique map that can be used to identify people. Dorsal hand vein pattern is a reliable and stable trait compared to other hand features because it is an internal pattern under skin layer. It cannot be damaged. Vein pattern is not prone to external distortion likes scars, skin-coloring and burns; it does not involve any physical contact with sensors. Vein pattern cannot be detected using normal visible light since it is beneath skin's surface but it can be easily captured using far or near infra-red radiation sensor. Far-Infrared (FIR) imaging produces very low contrast vein images, made it hard to segment vein foreground from background for further processing. On the other hand, Near-Infrared (NIR) Imaging produces better vein image compared to FIR imaging, which made NIR imaging more accepted for capturing vein pattern [1].

Many researchers have developed several personal identification system using combination of different vein features and classification methods, but development of reliable human identification systems using vein image requires viable classifier and robust features. M.Rajalakshmi1 et al [2] developed a method that used adaptive histogram equalization and median filtering for image enhancement. Feature was extracted from thinned vein endings and bifurcations using 3×3 window. Authentication of persons was done using triangulation matching method. Also Gayathri S et al [3] proposed a method that acquired vein images and enhanced them using histogram equalization. Features were extracted from vein skeleton and authentication of users was done using correlation. In [4] hand vein recognition method was developed, vein features were extracted using Principal Component Analysis (PCA) followed by Independent Component Analysis (ICA). Bosphorus hand vein database was used for the experiment. And Cosine Similarity Measure (CSM) was used to calculate matching scores. Chaitanya et al [5] proposed a system that used a low-cost NIR imaging equipment to capture hand vein images, features were extracted from vein bifurcations, endings and knuckle points. User authentication was performed using average matching score distances. In [6], phase information was extracted from vein images using Gabor filter for every pixel position in the image. Six frequency coefficients of phase information were quantized and used to form a feature descriptor code. Identification of users was done using minimum distance classifier.

Also Mohit Soni et al [7] developed hand vein based recognition system; features called ridge forking were extracted from vein skeleton using number of connected pixels. Euclidean distance based matching technique was used to establish users identification.

In most previous works, researchers' extracted minutiae based features from vein ending and bifurcation points, these features are not effective in describing vein pattern completely for accurate image classification but in this work more effective personal identification method is proposed that uses edge detected hand vein pattern and two different classifiers, geometric features are extracted from the whole edge detected vein pattern as input data to two different classifiers called Support Vector Machine and Euclidean Distance Measure.

This paper is structured into five sections. Introduction of the topic is done in section 1, section2 describes the proposed system, image acquisition method and image pre-processing techniques, Section 3 introduces the new feature extraction method, experimental result is shown in section 4, and finally, conclusion is established in section 5.

SYSTEM DESCRIPTION AND INPUT IMAGE

Personal hand vein based identification method proposed in this work involves capturing of dorsal hand vein using NIR imaging, followed by image preprocessing techniques namely median filtering and contrast enhancement. At feature extraction stage, geometric features are extracted from edge detected vein pattern thereafter feature vector is formed and used to generate users' templates. Finally identification of people is done using two different classifiers called SVM and EDM. The system block diagram is as shown in figure 1.

Input Hand Vein Imaging

Grey-level hand vein images were captured using a low cost NIR imaging equipment. Images were collected from thirty people; six images were acquired per person. Users were allowed to position their hands in such way that the dorsal hand part receives rays from ring of NIR LEDs and images were thereafter captured by camera modified to allow NIR rays to pass through the object and block visible rays.

Vein image pre-processing

The captured images have low contrast and contain noise. The images are processed by contrast enhancement and noise reduction technique to ensure quality images are sent to subsequent steps. The speckling noise in the acquired hand vein images were removed using median filter. A 5x5 median filter is applied to eliminate the effect of noise and preserves image edges.

The essence of image enhancement process is to adjust image intensity values to reveal image unique characteristics. Before any enhancement process is done, the histogram of the concerned image needed to be analysed as to choose a suitable image enhancement method. Histogram of an image shows the number of occurrence of grey values in an image. There are 256 possible intensity values in an 8-bit grey-level image therefore the histogram graphically shows distribution of pixels amongst those intensity values. Therefore image histogram is the deciding factor used to determine appropriate enhancement operation.

Contrast stretching and histogram equalization are the two major image enhancement methods used to improve image contrast, they operate on image to give maximum contrast using the full intensity range. Contrast stretching method is used to spread distribution of image intensity values which are compressed on short interval of the full intensity range while histogram equalization algorithm acts on a grey level image that has irregular distribution of intensity values, that is most of the pixels have values clustered in a small area, the aim of the process is to redistribute pixels evenly over the whole intensity range.

In this work adaptive histogram equalization is employed to enhance hand vein images, this method provides better output compared to normal histogram equalization in the sense that the method operates on the whole image by performing histogram equalization on smaller parts of the image and thereafter combining all the outputs to give global result. Example of grey level vein image and corresponding enhanced image is shown in figure 2a and 2b respectively.

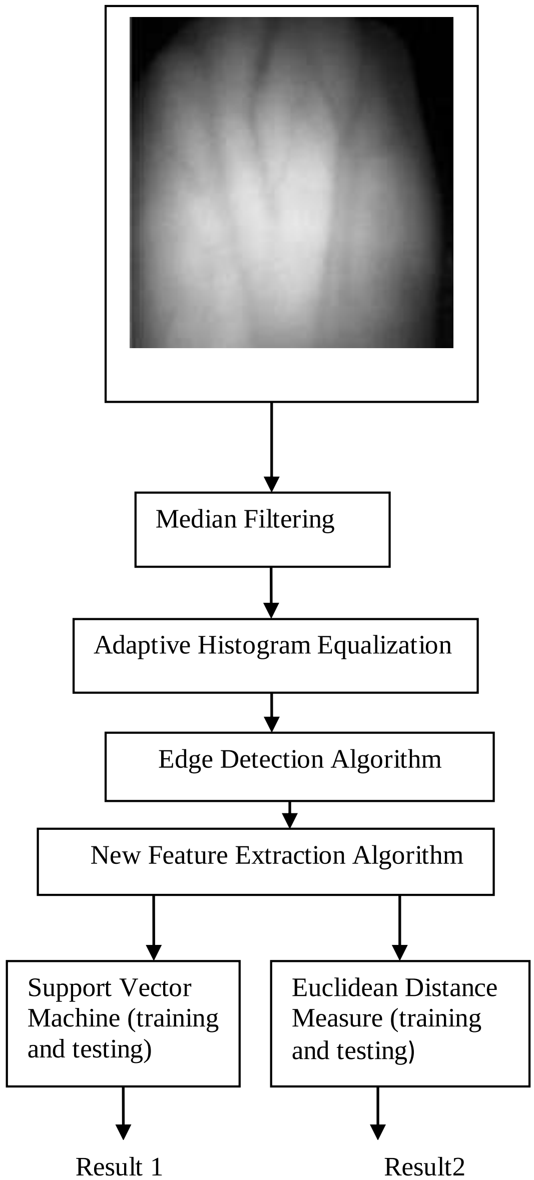

Figure : 1, Block diagram of the proposed system

Vein Image Detection Method

In this work, edge detection algorithm is engaged to obtain distinctive vein pattern instead of thresholding as it was done in some previous systems [5][7][8][9]. Edge detection algorithm uses intensity changes in grey-level image to produce connected points and curves called edges within the image. There are two major techniques of detecting edges in images and they are known as search and zero-crossing based method. In search-based methods edges in image (S) is identified by calculating first-order derivative of intensity change in an image so as to define magnitude (M) and orientation (θ) as given in (1),(2),(3),(4). In the case of zero-crossing based techniques, edges are detected at zero crossing points using second-order derivative of the intensity change in image. Figure 3 shows example of edge detected vein images using canny edge detection algorithm [10].

(a) *(b)*

Figure. 2, Grey-level hand vein imageand corresponding enhanced image

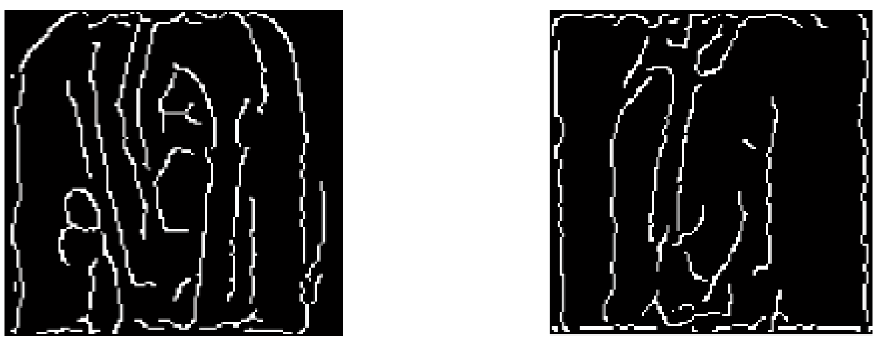

Figure.3, Edge detected vein patterns.

$$\frac{\partial S}{\partial x} = S[i, j] * Gx \qquad (1)$$

$$\frac{\partial S}{\partial y} = S[i, j] * Gy \qquad (2)$$

$$M[i, j] = \sqrt{\frac{\partial S}{\partial x}^{2} + \frac{\partial S}{\partial y}^{2}} \qquad (3)$$

$$\theta[i, j] = \arctan\left(\frac{\partial S / \partial y}{\partial S / \partial x}\right) \qquad (4)$$

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NEW FEATURE EXTRACTION METHOD

Feature extraction method is required to transform image to numerical values which can be used to describe image completely for classification purpose. In this study, the input image to the feature extraction stage is the edge detected vein pattern. Geometrical features are extracted from vein pattern to form feature vector that is more robust in discriminate hand vein images of different people.
The steps involved are as follows:

- Obtain perimeter of all the connected pixels in the image and quantize to twenty one values
- Obtain area of all the connected pixels in the image and quantize to twenty one values
- Calculate the average minor axis of image using first column vector.
- Calculate the average minor axis of image using second column vector.
- Calculate the average minor axis of image using third column vector.
- Calculate the average minor axis of image using fourth column vector.
- Obtain the mean value of major axis of image using first column vector.
- Obtain mean value of major axis of image using second column vector
- Create feature vector of 48 elements from value obtained from previous steps as given in (5).

$$h = [h_1, h_2, \text{-------}, h_{47}, h_{48}] \qquad (5)$$

EXPERIMENTAL RESULT USING SVM AND EDM

Viability of the proposed personal identification system involved hand vein pattern and two different classifiers was determined by testing the system using two out of six hand vein images collected from thirty people. Three hand vein images from each user are sent to training algorithm based on Support Vector Machine (SVM) at same time to Euclidean Distance Measure (EDM) to generate model parameters for each user.
Support Vector Machine (SVM) is a classification algorithm that uses optimal hyper plane to separate feature values into different clusters using structural risk minimization technique. The linear learning decision function f(x) can be defined by the input data (x), weight vector (w) and a threshold (b) as given in (6). SVM tackles non-linearly separable data by transforming original input feature space into a higher level feature space using nonlinear kernel [11]

$$f(x) = sign[w.x + b] \qquad (6)$$

The proposed system based on SVM is trained using negative and positive hand vein features to determine distance of separation between support vectors that is feature vectors at the margins of the optimal hyper-plane. Classification of query person hand vein image is obtained based on distance of the query feature vector from the optimal hyper–plane. Euclidean Distance Measure (EDM) is a widely used metric for measuring distance between feature vectors [12]. EDM classify query hand vein image by comparing the feature vector (h) with the user template vector (t) to get the minimum distance (d) between them. A minimum distance between two feature vectors indicate large similarity as given in (7)

$$d = \sqrt{\sum_{f=1}^{48} (h_f - t_f)^2} \qquad (7)$$

Sixty query hand vein images were sent to the system for identification, the images passed through all the stages to the classifier for authentication users based on stated model parameters. 90% of the query images are identify correctly by Euclidean Distance Measure (EDM) and 95% of test images gave correct matching using Support Vector Machine (SMV).

CONCLUSION

A more reliable hand vein based personal identification system has been developed. The system incorporated geometric features extracted from whole vein pattern and two different classifiers. SVM classifier performance surpasses that of EDM using the same feature data. It is shown clearly that this type of system will be helpful in detecting imposters for accessing facilities.

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