Biometric Authentication System based on Hand Vein Patterns

Shashidhara K S¹ Dr. Shailaja K²
¹M.Tech. Student ²Associate Professor
¹,²Department of Information Technology
¹,²SJCE Mysore

Abstract— A reliable biometric system, which is essentially a pattern-recognition that recognizes a person based on physiological or behavioral characteristics. Nowadays, security has been important for privacy protection and country in many situations, and the biometric technology is becoming the base approach to solve the increasing crime. Biometric characteristics include fingerprint, face, hand/finger geometry, iris, retina, signature, voice, hand vein, DNA information, while fingerprint, face, iris and signature are considered as traditional ones. But they all have few disadvantages. Vein patterns are sufficiently different across individuals, and they are stable unaffected by ageing and no significant changed in adults by observing. It is believed that the patterns of blood vein are unique to every individual, even among twins.

Key words: Biometric Authentication System, Hand Vein Patterns

I. INTRODUCTION

The shape of the subcutaneous vascular tree of back of hand contains information that is capable of authenticating the identity of an individual.

Fig. 1: Example of the generic vascular map on the hand dorsal surface.

Figure 1.1 illustrates the generic vascular map found on the dorsum of the hand. There are mainly two types of hand-veins found on the dorsum of the hand, namely cephalic and basilic. The basilica veins are the group of veins attached with surface of hand and marked as “2” in Figure 1.1. It generally consists of upper limb of the back of hand. The Cephalic veins are the group of veins attached with the elbow of the hand and marked as “1” in Figure 1.1.

Hand-vein recognition has more advantages compared to other biometric feature authentication technology.

The advantages are as follows:

- Non-contact: Contact need not be established between the hand and the device, while extracting the vein pattern. Hence it is hygienic and there is no scope for duplication.

As an overview Hand Dorsal-Vein Pattern Recognition System consists of an easy to implement device that takes a snapshot of the subject’s veins under a source of infrared radiation at a specific wavelength and uses this unique feature for recognition systems.

A paper published by Debnath Bhattacharyya; "Vascular Pattern Analysis towards Pervasive Hand Vein Authentication"[1] in which they purposed three algorithms for preprocessing [1] area. Vascular Pattern Marker Algorithm (VPMA); in which the two pass masking is used such as horizontal and vertical kernels to smoothen the image. Vascular Pattern Extractor Algorithm (VPEA); in which Thresholding is done for converting a grey scale or color image to a binary image based upon a threshold value. Thus creating a binaries image, or an image with only 2 colors, black (0) and white (255). Vascular Pattern Thinning Algorithm (VPTA) in which thinning is done for capturing the Vascular Pattern of hand of an individual. The resultant Images will be stored in a Database, as the vascular patterns are unique to each individual, so future authentication can be done by comparing the pattern of veins in the hand of a person being authenticated with a pattern stored in a database.

Here the threshold value is assumed which is not always the criteria.

The paper published by Jing-Wein Wang, on “Building Hand Vein Capturing System for Extraction” [2]. First phase is pre-processing in which the various steps are carried out to improve the image quality such as image enhancement, a bit-level thresholding, noise removal. Second phase is feature extraction in which the vein features are extracted by “pixel by pixel” scanning, in order to identify connected pixel regions. Third step is post-processing in which thinning is done to remove the unnecessary information the performance of accurate extraction ratio is very good but the error extraction due to bad quality of hand vein pattern images may lead to the fatal errors of the process.

A paper published by Huan Zhang, on “A Hand Vein Recognition System” [3] In which they purposed a capturing device, a JAI AD-080 CL 1/3” CCD near-infrared camera is used. In preprocessing the inscribed circle-based segmentation which extracts the ROI. Image is then smoothed by the Gaussian smooth filter; local contrast enhancement is used to enhance the ROI image.

A paper published by Qing Rao, on “Personal Identification for Single Sample Using Finger Vein Location and Direction coding” [4] in which they propose a finger vein imaging device with near-infrared (NIR) light source. Then they do pre-processing of the image in which they use
gradient operator, size and brightness normalization for feature extraction and final matching.

II. SYSTEM OVERVIEW

A hand-vein recognition system is a system in which hand-veins are compared, resulting as matching or not matching based on certain feature to provide access. To implement any hand-vein recognition system, therefore needs various processes. First, hand-vein images have to be captured using CCD cameras, and then those extracted vein images have to be processed to make those images suitable to extract features. These features are compared from the features extracted from the database. Therefore, any hand-vein system can be divided into the following five major stages. This is depicted in the Figure 2 as shown below.

The five stages are:
1) Hand-vein image acquisition
2) Preprocessing
3) Image segmentation
4) Feature extraction
5) Matching

![Block diagram of hand vein recognition system.](image)

A. Image Acquisition:
Vein images are captured in the special wavelength of infrared light from 750 to 1100 nm, Infrared light is made to shine onto the hand. This in turn gives captured images of the hand-vein. In this system, the captured images in BMP format.

![Visible light image and infrared(IR) image.](image)

The cropped version of the captured image is composed of the vein pattern, along with unnecessary and unwanted information that needs to be removed. The system step which aims to enhance and extract the vein pattern is called image processing. It is divided in three steps: preprocessing, segmentation and post-processing.

B. Preprocessing:
Preprocessing reduces noise in the cropped image which could be the result of hairs or poor camera performances.

This helps to improve the quality later on when the image is segmented. Different methods are used for preprocessing, and often they are a combination of several filters and algorithm. Choi for instance, applies a high-pass filter and then histogram based binarisation. Both of these are made to enhance the contrast. Afterwards a median filter is applied to remove noise due to hair[5]. In a different paper, Wang and Leedham [6] used a median filter along with a Gaussian low-pass filter, for double noise reduction (stipple noise with the Gaussian filter and noise due to hairs with the median filter). Once the noise has been reduced, the image goes through segmentation.

C. Image Segmentation:
Segmentation subdivides an image into its constituent regions or objects that have similar features according to a set of predefined criteria. The features involved are intensity histogram, mean, variance, energy, texture etc. the level of detail to which the subdivision is carried depends on the applications or the problem being solved. Segmentation algorithms are based on one of two basic properties of intensity values: discontinuity and similarity.

1) Thresholding:
Thresholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value. There are three types of thresholding global thresholding, local thresholding, and dynamic (adaptive) thresholding. In these methods adaptive thresholding is employed. the local threshold is to statistically examine the intensity values of the local neighborhood of each pixel. The statistic which is most appropriate depends largely on the input image. Simple and fast functions include the mean of the local intensity distribution, the median value, or the mean of the minimum and maximum values. The size of the neighborhood has to be large enough to cover sufficient foreground and background pixels, otherwise a poor threshold is chosen. On the other hand, choosing regions which are too large can violate the assumption of approximately uniform illumination.
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Fig. 5: Before adaptive thresholding.

Fig. 6: After adaptive thresholding.

D. Post Processing

In order to ensure that the unwanted noise is effectively removed from the image. Noise removal Digital filter is a system that performs mathematical operations on a sampled, discrete-time signal to reduce or enhance certain aspects of that signal. In this system, Median filter is a type of order statistic filter which replaces the value of the centre pixel by the median of the intensity values in the neighborhood of that pixel. They are particularly effective in the presence of impulse noise.

E. Matching

The correlation between two signals (cross correlation) is a standard approach to feature detection as well as a component of more sophisticated techniques. Normalized cross correlation is a mathematical computation that fulfills an essential role in image processing. This is adopted to achieve matching.

Fig 7: Post Processing- after noise removal.

Fig 8: 3D plot of correlation coefficients for authenticate veins.

Fig 9: 3D plot of correlation coefficients for non-authenticate veins.

III. CONCLUSION

The current work presents a new improvised algorithm for hand-vein recognition. This process involves a number of steps within itself like segmentation and feature extraction. Various mathematical tools which contain several stages like centroid determination, contrast enhancement and calculation of correlation coefficients have been used. The result of recognition stage performs the non-improvised algorithm by having a high matching ratio.

REFERENCES


