International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

Infrared Vein Detection System for Person Identification – An Image Processing Approach

Manjiree S. Waikar[1], Dr. S. R. gengaje[2]

[1]*Student, Electronics Department, Walchand Institute of Technology, Solapur, MH, India*
[2]*Dr. S. R. Gengaje, H. O. D., Electronics, Walchand Institute of Technology, Solapur, MH, India*

---***---

Abstract - *A lot of research has been done on the use of Infrared radiations (IR) for a biometric application which is a very new and interesting concept. It provides a promising result in the field of security and biomedical application. Identification of person with the help of vein patterns is a recent approach, that uses vein mesh underneath a person's skin. The vein patterns are unique for each individual. As veins are present under the skin, they are difficult to copy. The uniqueness and stability of the vein patterns provide a good biometric feature for identification of the person. This paper proposes a method, to detect the veins using an infrared illuminator and then enhancement of vein images is done by using different techniques for identifying the person. The proposed work is related to the implementation of Infrared vein detection and matching system for person identification. A novel scheme is proposed, in which the vein image captured in an infrared illuminator is used. The proposed system is implemented using MATLAB.*

Key Words: Infrared (IR), Near Infrared (NIR), Far Infrared (FIR), Region of Interest (ROI), Adaptive Histogram Equalization (AHE), Projection Matrix (PM)

1. INTRODUCTION

Vein identification is useful for forensic purposes as veins are our unique identity. Biometric identification using vein patterns is a very new and interesting concept that uses the vast network of blood vessels underneath a person's skin. These vein patterns in the hands are assumed to be unique for each individual and they do not change over time except size. An attempt to copy one's identity is extremely difficult as veins are present under the skin and have a wealth of differentiating features. The property of being unique and strong immunity to the imitation of the vein patterns offers greater security for identification of a person.

The subcutaneous vascular pattern or network on the back of the hand is referred as the hand vein. Figure. 1 shows the broad vascular map found on the dorsum of the hand. There are two types of hand veins found on the dorsum of the hand, they are cephalic and basilic veins. Basilica veins are the group of veins attached to the back surface of the hand and marked as "2" in figure 1.1. It generally consists of the upper limb of the back of the hand and Cephalic veins are the group of veins attached to the elbow of the hand and marked as "1" in Figure 1. The identification system is described as a 1 to n matching system, where n is the total number of biometrics present in the database. Palm vein authentication has a high level of authentication accuracy due to the complexity and uniqueness of vein patterns of the palm. Because the palm vein patterns are internal to the body, this would be a difficult system to forgery.

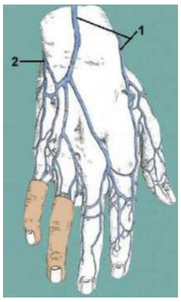


Fig – 1: Broad vascular map on the palm dorsal surface

Nowadays an infrared imaging is most widely used in the medical field because it is non-invasive. There are two types of infrared (IR) imaging, Near Infrared (NIR) imaging and Far Infrared (FIR) imaging. There is a medical spectral window from about 700 to 900 nm where light penetrates deeply into tissues. Therefore, with a wavelength around 850 nm, the infrared light beam coming out from a light source is selected to be within the near Infrared region. NIR avoids undesirable interference from the IR radiation (3um-14um) emitted by the human body and the environment using this wavelength. NIR radiation is used because the Near Infrared light is absorbed more strongly by human blood than the surrounding tissue, and thus veins appear darker.

2. RELATED WORK

Image processing is first developed in 1960. It is developed through the association of many scientists and academics. It has gained more importance in present day lives. There are three major benefits of digital image processing namely consistent high quality of an image, low cost of processing and the ability to manipulate all features of a process.

In digital image processing field, Image enhancement is one of the most interesting and an important concept. In Image enhancement details that are hidden in an image are brought out and also the contrast in a low contrast image is increased. Image enhancement produces an output image that subjectively looks better than the original image. It changes the pixel's intensity of the input image. It also enlarges the intensity differences among objects and background.

Biometrics is used for many different purposes, but they are part of either a verification system or an identification system. The difference between these two types of systems is how quickly the system operates and how accurate it is, as the size of biometric database increases.

Most of the algorithms from literature use regular, low-cost, near IR contactless imaging RGB camera to obtain reflectance information from veins of dorsal hand images. J. Hee Song et al.,[1] introduced Vein visualization using a smartphone with Multispectral Wiener Estimation for point-of-care Applications. In the proposed method, a conventional RGB camera on a private smartphone has been used to obtain reflectance information from veins. Wiener estimation is then applied to get the multispectral information from the veins. To evaluate the performance an experiment has been conducted using a color calibration chart and an average root mean square error of 12.0 % has been obtained.

A.Kumar et al.,[2] proposed Personal Authentication Using Hand Vein Triangulation and knuckle shape. The proposed method has been fully automated and employs dorsal hand vein images obtained from the low-cost, near IR contactless imaging camera. The knuckle tips are used as key points for the image normalization and to extract the region of interest. The experiment has been performed on 100 users and equal error rate of 1.14% has been achieved.

Zhi Liu and Shangling Song et al.,[3] presented An Embedded Real-Time Finger-Vein Recognition System for Mobile Devices. They proposed simple, convenient and high-security authentication system to protect private information stored in mobile devices. The proposed system provides finger-vein recognition system based on the blanket dimension and lacunary implemented on a DSP platform. The proposed system takes only about 0.8 seconds to verify one input finger vein sample and achieved an equal error rate (EER) of 0.07% on a database of 100 subjects.

Ajay Kumar et al.,[4] proposed human identification system using palm vein images. In proposed approach, two different databases have been used with contactless and touch-based imaging setup. The Hessian-phase-based and Radon transform is used to extract the feature from palm vein images. This approach achieved zero percent EER for both databases.

Aycan Yuksel, Lale Akarun, Bulent Sankur.,[5] proposed Hand vein biometry based on geometry and appearance methods. In proposed approach, a novel hand vein database and a biometric technique based on the statistical processing of the hand vein patterns are used. The BOSPHORUS hand vein database has been used. It is collected under realistic conditions where subjects had to undergo the procedures of holding a bag, pressing an elastic ball and cooling with ice such exercises that force changes in the vein patterns. The applied recognition techniques are the collaboration of geometric and appearance-based techniques and good identification performances have been obtained from the database.

Erdem Yoruk, Bulent Sankur, [6] proposed Shape-based hand recognition. In a pre-processing stage of the algorithm, the silhouettes of hand images are registered to a fixed pose, which involves both rotation and translation of the hand and, separately, of the individual fingers.

3. PROPOSED IDENTIFICATION SYSTEM

Figure 2 shows a block diagram of proposed system. The image of dorsal palm vein is captured using a monochrome NIR CCD camera. The captured image is in the RGB format but further algorithm deals with the grayscale image. Extraction of ROI is then followed by Contrast Enhancement method. Then edges are detected for vein detection purpose. Extraction and matching of features are done for identification of a person.

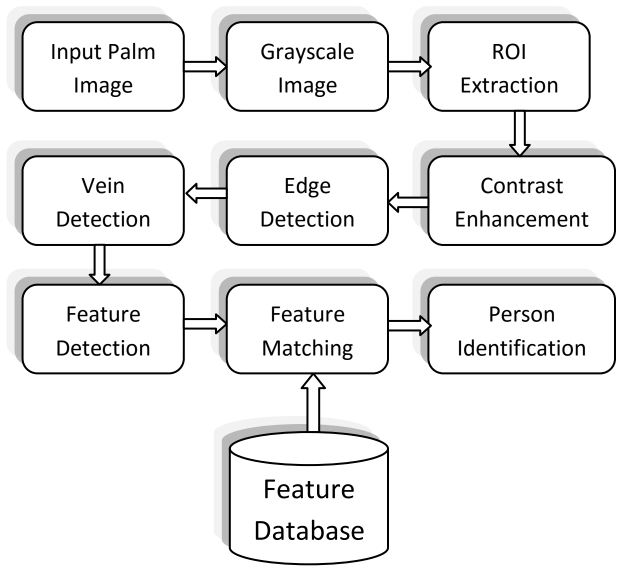


Fig – 2: Proposed System for Identification of Person

3.1 Formation of Database

Reproducibility of results is a needful requirement for the advancement of a technology. Although there are an increasing number of papers reporting good recognition results, their results are not reproducible as none of them allow open access to their database. Thus in our research, suitable standard dorsal hand vein database available on the internet, called 'BOSPHOROUS' is used. The database is presently open access at http://bosphorus.ee.boun.edu.tr/.

The respective database consists of 3 images each for 100 different people. There are two different phases – training phase and testing phase. Training phase consists of 2 images each of 100 different people and testing phase consists of 1 image each of respective 100 people. There are total 300 images of dorsal hand under normal condition. Each training image is preprocessed and features of those images are stored in the database for person identification.

Figure 3 shows the captured image of person number 40 in that first two images are from training phase and 3rd image is of the testing phase.

(a) (b) (c)

Fig – 3: (a) and (b) shows training images of person number 40, and (c) shows testing image of the same person

Features of training images are obtained and then stored in the database. Now, the features of a testing image are obtained for matching and identification purpose.

3.2 ROI Extraction

The next step is to crop the image. In vein images, the region which contains the information of the vein patterns is the region of interest. Then from the grayscale image, the region of interest (ROI) is extracted. The ROI is cropped manually by dragging the square of size 80 X 80 on particular interested vein region and then by double clicking on that square it shows only cropped portion of the image. Figure 4 shows the extracted ROI of a testing image of person number 40.

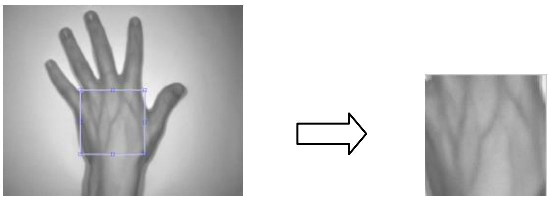


Fig – 4: ROI of testing image of person number 40

3.3 Contrast Enhancement Method

Adaptive Histogram Equalization is a contrast enhancement method. Ordinary Histogram Equalization operates on an entire image but AHE operates on small regions in the image called 'tiles'. Each tile's contrast is enhanced and then the neighboring tiles are combined to eliminate artificially induced boundaries. Figure 5 shows the enhanced ROI of a testing image of person number 40.

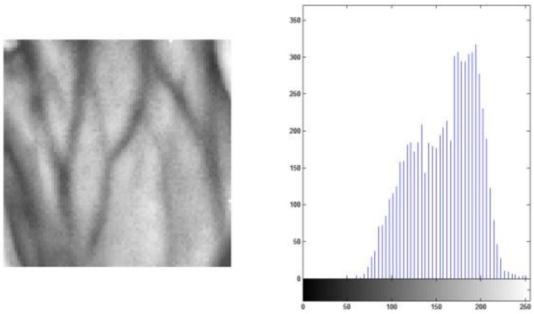


Fig – 5: Adaptive Histogram Equalized ROI of person number 40

3.4 Edge Detection

To detect the boundaries of objects within images Edge Detection technique is used. It works by detecting discontinuities in brightness. Here Canny Edge Detection technique is used for Edge Detection. The Canny edge detection technique is used to extract useful structural information from the image and reduce the amount of data to be processed. It provides a good and reliable detection of veins in the Adaptive Histogram Equalized image. Figure 6 shows the output after Edge Detection.

Fig – 6: Edge Detected ROI of person number 40

3.5 Feature Extraction

Radon Transform technique is used for extraction of features. Applying the Radon transform to an image f(x,y) for a given set of angles can be thought of as computing the projection of the image along the given angles. The resulting projection is the sum of the intensities of the pixels in each direction, i.e. a line integral. A straight line in Cartesian coordinates can be described as:

$$x\cos\theta + y\sin\theta = \rho$$

And Radon Transform can be written as:

$$R(\rho,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\delta(\rho - x\cos\theta - y\sin\theta)dxdy$$

The Radon Transform is a mapping from the Cartesian Rectangular co-ordinates (x,y) to a distance and an angle (ρ,θ), also known as polar coordinates. The complete Radon transform of the preprocessed image of person number 29 looks like Figure 7. The white spot is the distance from the center and the angle at which the sum of the intensities of the image peaks.

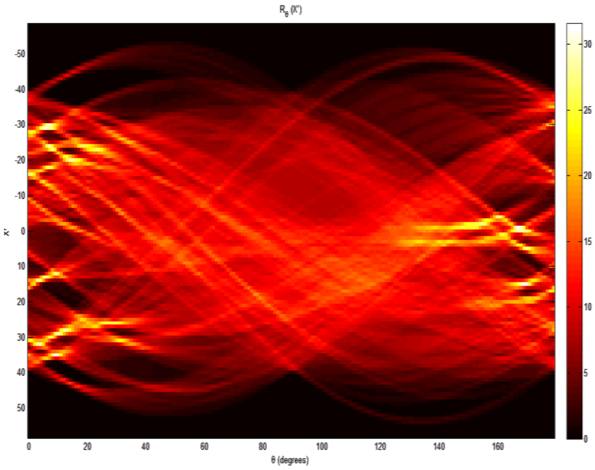
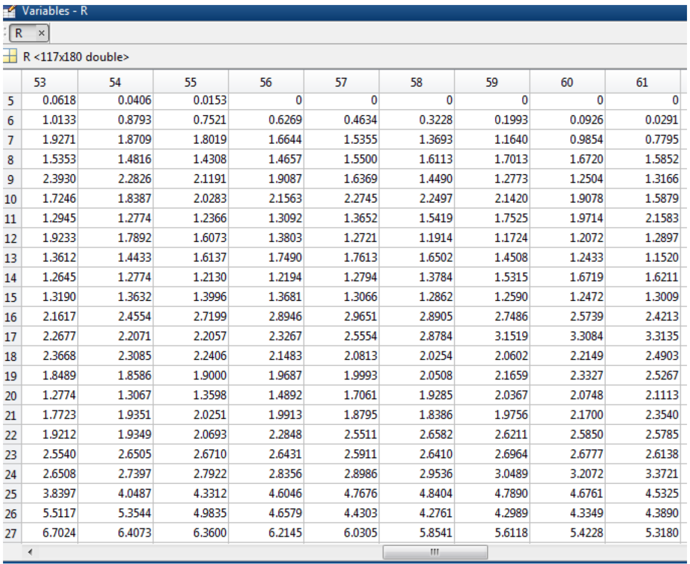


Fig – 7: Sinogram of fig – 6 after applying Radon Transform

For a mathematical purpose, to extract the line parameters from the input vein image the Radon Projection matrix is obtained. After applying theta the projection matrix is obtained in which the number of projection values for the particular theta are obtained. The projection matrix of person number 40 is shown in figure 8.



Variables - R

R

R <117x180 double>

	53	54	55	56	57	58	59	60	61
5	0.0618	0.0406	0.0153	0	0	0	0	0	0
6	1.0133	0.8793	0.7521	0.6269	0.4634	0.3228	0.1993	0.0926	0.0291
7	1.9271	1.8709	1.8019	1.6644	1.5355	1.3693	1.1640	0.9854	0.7795
8	1.5353	1.4816	1.4308	1.4657	1.5500	1.6113	1.7013	1.6720	1.5852
9	2.3930	2.2826	2.1191	1.9087	1.6369	1.4490	1.2773	1.2504	1.3166
10	1.7246	1.8387	2.0283	2.1563	2.2745	2.2497	2.1420	1.9078	1.5879
11	1.2945	1.2774	1.2366	1.3092	1.3652	1.5419	1.7525	1.9714	2.1583
12	1.9233	1.7892	1.6073	1.3803	1.2721	1.1914	1.1724	1.2072	1.2897
13	1.3612	1.4433	1.6137	1.7490	1.7613	1.6502	1.4508	1.2433	1.1520
14	1.2645	1.2774	1.2130	1.2194	1.2794	1.3784	1.5315	1.6719	1.6211
15	1.3190	1.3632	1.3996	1.3681	1.3066	1.2862	1.2590	1.2472	1.3009
16	2.1617	2.4554	2.7199	2.8946	2.9651	2.8905	2.7486	2.5739	2.4213
17	2.2677	2.2071	2.2057	2.3267	2.5554	2.8784	3.1519	3.3084	3.3135
18	2.3668	2.3085	2.2406	2.1483	2.0813	2.0254	2.0602	2.2149	2.4903
19	1.8489	1.8586	1.9000	1.9687	1.9993	2.0508	2.1659	2.3327	2.5267
20	1.2774	1.3067	1.3598	1.4892	1.7061	1.9285	2.0367	2.0748	2.1113
21	1.7723	1.9351	2.0251	1.9913	1.8795	1.8386	1.9756	2.1700	2.3540
22	1.9212	1.9349	2.0693	2.2848	2.5511	2.6582	2.6211	2.5850	2.5785
23	2.5540	2.6505	2.6710	2.6431	2.5911	2.6410	2.6964	2.6777	2.6138
24	2.6508	2.7397	2.7922	2.8356	2.8986	2.9536	3.0489	3.2072	3.3721
25	3.8397	4.0487	4.3312	4.6046	4.7676	4.8404	4.7890	4.6761	4.5325
26	5.5117	5.3544	4.9835	4.6579	4.4303	4.2761	4.2989	4.3349	4.3890
27	6.7024	6.4073	6.3600	6.2145	6.0305	5.8541	5.6118	5.4228	5.3180

Fig – 8: Projection Matrix

3.6 Feature Matching and Result Display

While doing matching the maximum correlation coefficient between Radon projection matrix of the testing image and PM of all the 200 stored training images is calculated. Then out of those 200 correlation coefficients, a maximum value is obtained and the respective image from the training phase is taken into consideration. If the considered image from the training database and the input image from the testing database belongs to one person then the result is displayed as "Correct Identification of Person". Otherwise, the result is displayed as "Incorrect Identification of Person".The maximum correlation coefficient for person number 40 is 0.7855 and it displays the result as "Correct Identification of Person".

4. EXPERIMENTAL RESULTS

The proposed algorithm is implemented using MATLAB. All the images are taken from BOSPHORUS Database. After performing the experiment for all the 100 test images, we created a confusion matrix. Confusion matrix is a table used to describe the performance of a classification model on a set of test data for which the true values are known. There are two cases – True Positive (TP) and False Positive (FP). True Positive is the case in which we predict yes and even the person identification is correct. False Positive is the case in which we predict yes but the person identification is incorrect.

N = 100	**Predicted YES**
Actual NO	**FP = 08**
Actual YES	**TP = 92**
Total = 100	

Accuracy = TP / Total

Error Rate = FP / Total

The overall accuracy of proposed system is 92%.

5. CONCLUSION

Using proposed methodology, infrared vein detection for identification of a person is done. We have shown that hand vein pattern biometry is a promising technique. The proposed work is limited to NIR images. The program is written in MATLAB. The BOSPHORUS database is presently publicly available for the sake of reproducible results at http://bosphorus.ee.boun.edu.tr/. In future, person verification can be done.

REFERENCES

[1] Jae Hee Song et al., "Vein Visualization using the smartphone with Multispectral Wiener Estimation for Point-care-Application." IEEE Journal of Biomedical and Health Informatics,pp.1-7.2014.

[2] Ajay Kumar, et al., "Personal Authentication Using Hand Vein Triangulation and Knuckle Shape.", IEEE Transaction on Image Processing. Vol.18, no.9,pp2127-2136.September 2009.

[3] Zi Liu and Shangling Song et al., "An embedded real-time finger-vein recognition system for mobile devices", IEEE Transaction on consumer electronics., vol. 58, no.2, pp. 522-527, May 2012.

[4] Ajay Kumar et al., “Human Identification Using Palm Vein Images”, IEEE Transaction on Information and Security, vol. 6, no. 4, pp. 1259-1274, Dec 2011.

[5] Jie Cao et al., "My Palm Vein: A Palm Vein-based Low-cost Mobile Identification System For Wide Age Range", 17th International Conference on E-health Networking Application & Services 2015.

[6] N. Miura, A.Nagasaka, T. Miyatake, "Feature extraction of finger-vein patterns based on repeated line tracking and its application to Person Identification", Machine Vision and Applications, vol.15, no.4, pp.194-203,2004.

[7] M. Ramalho, P.L.Correia, L. D. Soares et al., "Biometric identification through palm and dorsal hand vein patterns", in EUROCONInternational Conference on Computer as a Tool (EUROCON), IEEE. IEEE, 2011,pp.1-4, 2011.

[8] Y-B Zhang, Q. Li, J. You, and P.Bhattacharya, "Palm Vein extraction and matching for personal authentication", in Advances in Visual Information Systems. Springer, pp. 154-164, 2007.

[9] M.Kono, H.Ueki, and S.-i.Umemura,"Near-infrared finger vein patterns for personal identification”, Applied Optics, vol. 41, no. 35, pp. 7429-7436, 2002.

BIOGRAPHIES

Manjiree Sunil Waikar
PG Student, Electronics Department, Walchand Institute of Technology, Solapur.