DORSAL HAND VEIN PATTERN AUTHENTICATION BY HOUGH PEAKS

V.Krishna Sree[1], P.Sudhakar Rao[2]

[1]*Dept of ECE, VNR VJIET, Hyderabad, India*
[2]*Dept of ECE, VITS, Hyderabad, India*

Abstract

The quest of providing more secure identification system has led to rise in developing biometric systems. Biometrics such as face, fingerprint and iris have been developed extensively for human identification purpose and also to provide authentic input to many security systems in the past few decades. Dorsal hand vein pattern is an emerging biometric which is unique to every individual. In this paper Linear Hough transform is used to extract the features of query and data base images. K-Nearest neighbor Search is used to obtain best match between query image and database. The extraction of the vein patterns was obtained by morphological techniques. Noise reduction filters are used to enhance the vein patterns.

Keywords:- *Dorsal hand vein patterns, K-Nearest neighbor search, Morphological Techniques, Enhancement , Noise Reduction and Hough transform.*

---***---

1. INTRODUCTION

Personal identification systems are gaining lot of demand due to increased threats and attacks from the terrorists. These can be prevented by tightening the security at important places. The traditional methods make use of smart cards or personal identification numbers etc to identify a person. However these methods have limited security and are unreliable. Over the past years various biometric systems have been developed to overcome these disadvantages[5]. Biometrics is the science of identifying a person using its physiological or behavioral features. These features range from physical traits like fingerprints, faces, iris etc to represent the signature or personal behavior of a human being. Compared to traditional methods biometric features are much harder for intruders to copy or forge and it has one more advantage that it is very rare for them to be lost. Hence for identification systems making use of biometric features offer a much more secure and reliable performance. Each of these biometric features has its strengths and weaknesses. Vein pattern is the network of blood vessels beneath a person's skin. This vein pattern can be used to authenticate the identity of an individual.

Anatomically aside from surgical intervention the shape of the vascular patterns in the back of the hand is distinct from each other and it remains stable over along period[2]. In addition as the blood vessels are hidden underneath the skin and are invisible to the human eye, vein patterns are much harder for intruders to copy as compared to other biometric features[9], vein image which can be taken only at live body, Due to non-contact, it is hygienic and non-duplicating and has no negative image associated with crime. All these special properties of hand vein patterns make it a potentially good biometric to offer more secure and reliable features for personal verification[1]. Biometrics is a science for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits. Biometrics is used as a form of identity access management, access control and identifying individuals in groups under surveillance. Biometrics can be divided in two main classes that are physical and behavioral. Physical are related to the shape of the body like fingerprint, face recognition, DNA, palm print, hand geometry and iris of the eye. Behavioral are related to behavior of a person like voice, gait etc. The biometrics should have the certain characteristics like each person should have the said characteristic, it should distinguish individual from another, should be resistive to ageing, easy to acquire, should be accurate, robust, and should have acceptability. A biometric which possesses more number of characteristics is treated as a good bio-metric[6].

A biometric system can operate in two modes, one is Verification and Identification. Verification is the one to one comparison of a captured biometric with a stored template to verify that the individual is who he claims to be. Can be done in conjunction with a smart card, user ID number etc. Identification is a one to many comparisons of the captured biometric against a biometric data base in attempt to identify an unknown individual. The identification only succeeds in identifying the individual if the comparison of the biometric sample to a template in the data base falls within a previously set threshold. Before the Verification or Identification an individual should enroll his information in the system to store it as template for subsequent uses. During the identification process, the Query image is matched with the set of templates available as data base with the help of some image processing algorithms. During this signature recognition, lot of comparisons need to be with every template in the database. Hough transform is used to identifythe featurepatterns in database as well as in the query image. KNNsearch is used to search for similarities between features of the query image and database in a speedy and effective manner. The memory requirements are reduced in KNN search which is very much needed in case of large database. In this work Hough transform in combination with KNN search is used for identifying the query hand vein pattern image from the data base of hand vein pattern images.

2. MATERIALS

Veins are hidden underneath the skin, and are invisible to the naked eye and other visual inspection systems. However human superficial veins have higher temperature than the surrounding tissue. Based on this fact, the vein pattern in the back of the hand can be captured using a thermal camera. In this work NEC Thermal tracer is utilized to acquire thermal images of the back of the hand. The images collected from differentpeople in a normal office environment between 20-25oc.One image of hand vein dorsal is shown in Fig. 1.

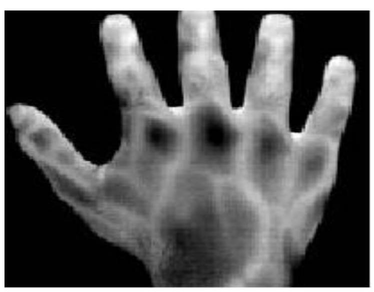

Fig.1: Thermal dorsal hand vein image

3. METHOD

The steps involved in the proposed work are given in Fig.2.

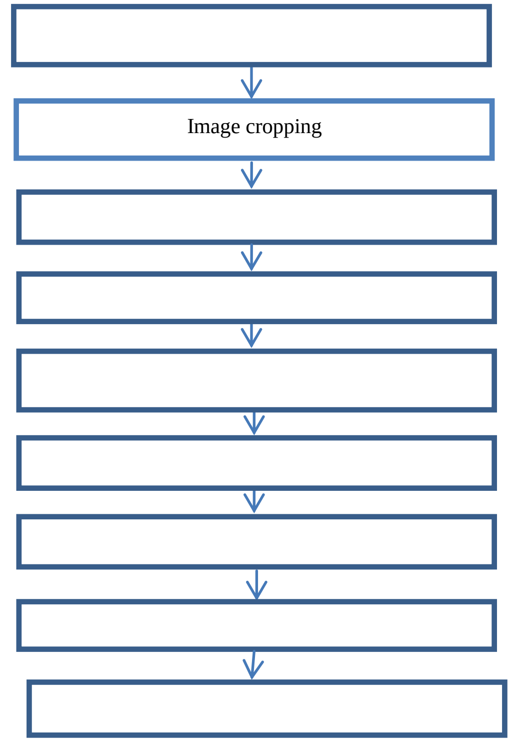

Fig.2: Steps Involved in the proposed technique

The input hand Vein pattern thermal images are cropped to extract the region of interest. The cropped images are grouped as training set. The training set is enhanced using adaptive histogram equalization. On equalized training set noise filtering is carried out to minimize the noise. Thinning is then performed to reduce the vein patterns into a pixel wide. Hough transform is applied on these thinned images to extract the Hough peaks and the corresponding radius(r) and angle (ϴ) values as feature vectors. For the Query image to be verified from the database is cropped, adaptive histogram equalized,filtered and thinned. The Hough peaks and the associated radius(r) and angle (ϴ)are extracted for that. And matching is performed by using KNN search.

3.1 Preprocessing

In preprocessing the hand vein pattern images are cropped to the required region of interest where veins look prominent. The portions of fingers are removed and to adjust the intensities uniformly adaptive histogram equalization has been carried out [4,7]. The collected data base is converted into training set. On this training set median filtering is applied to remove the noise. Thinning is performed as the final preprocessing step to extract one pixel wide vein patterns before the feature extraction.

3.2 Hough Transform

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing to find imperfect instances of objects within a certain class of shapes circles or ellipses by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform [3].In many cases an edge detector can be used as a pre-processing stage to obtain image points or image pixels that are on the desired curve in the image space. Due to imperfections in either the image data or the edge detector, however, there may be missing points or pixels on the desired curves as well as spatial deviations between the ideal line/circle/ellipse and the noisy edge points as they are obtained from the edge detector. Due to this, it is non-trivial to group the extracted edge features to an appropriate set of lines, circles or ellipses. The Hough transform is used to group the edge points into object candidates by performing an explicit voting procedure over a set of parameterized image objects.Hough transform is a linear transform for detecting straight lines. In the image space, the straight line can be described as y = mx + b and can be plotted for each pair of image points (x, y). In the Hough transform the characteristics of the straight line is considered not as image points, instead, in terms of its polar coordinate pair, denoted r and Θ (theta).The parameter r represents the distance between the line and the origin, whileΘ is the angle of the vector from the origin to this closest point. Using this parameterization, the equation of the line can be written as

$$y = \left(-\frac{\cos\theta}{\sin\theta}\right)x + \left(\frac{r}{\sin\theta}\right) \quad \text{--- (1)}$$

Which can be rearranged to

$$r = x\cos\theta + y\sin\theta \quad \text{--- (2)}$$

It is therefore possible to associate with each line of the image a pair (r,θ) which is unique if $\theta \in [0, \pi)$ and $r \in \mathbf{R}$, or if $\theta \in [0, 2\pi)$ and $r \geq 0$.

The (r,θ) plane is sometimes referred to as Hough space for the set of straight lines in two dimensions. This corresponds to a sinusoidal curve in the (r,θ) plane, which is unique to that point. If the curves corresponding to two points are superimposed, the location (in the Hough space) where they cross corresponds to a line (in the original image space) that passes through both points.The Hough transform algorithm uses an array, called an accumulator to detect the existence of a line. Two unknown parameters (r,θ) is the dimension of the accumulator array and it would correspond to quantized values for (r,θ). For each pixel and its neighborhood, the Hough transform algorithm determines if there is enough evidence of an edge at that pixel. If so, it will calculate the parameters of that line, and then look for the accumulator's bin that the parameters fall into, and increase the value of that bin. By finding the bins with the highest values, typically by looking for local maxima in the accumulator space, the most likely lines can be extracted, and theirapproximate geometric definitions read off. The simplest way of finding these peaks is by applying some form of threshold determining which lines are found as well as how many. Since the lines returned do not contain any length information, it is often necessary to find which parts of the image match up with which lines. The result of the Hough transform is stored in a matrix that often is called an accumulator. One dimension of this matrix are the angles θ and the other dimension are the distances r, and each element has a value telling how many points/pixels are positioned on the line with parameters (r,θ). So the element with the highest value tells what line that is most represented in the input image.

Hough peaks Identifies peaks in Hough transform.By performing the Hough transform the radius and theta values and the Hough peaks are calculated. The r and theta values of these Hough peaks are extracted into two matrices and the pattern recognition is done on these values. The Hough peaks are shown graphically in Fig.3.

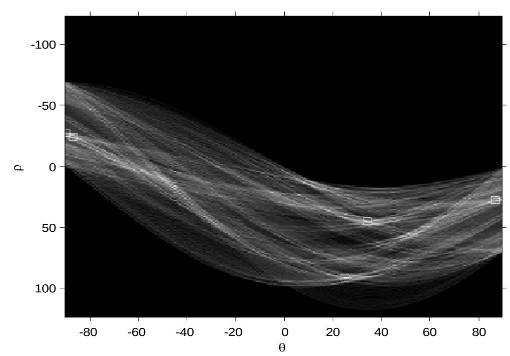

Fig.3. The Hough peaks which are represented by the small squares.

3.3 Recognition Procedure: KNN Search

KNNsearch is the nearest neighbor search in spaces with small intrinsic dimension. k-nearest neighbor search identifies the top k nearest neighbors to the query. This technique is commonly used in predictive analytics to estimate or classify a point based on the consensus of its neighbors. k-nearest neighbor graphs are graphs in which every point is connected to its k nearest neighbors. In those cases, we can use an algorithm which doesn't guarantee to return the actual nearest neighbor in every case, in return for improved speed or memory savings. Often such an algorithm will find the nearest neighbor in a majority of cases, but this depends strongly on the dataset being queried.Algorithms that support the approximate nearest neighbor search include locality-sensitive hashing, best bin first and balanced box-decomposition tree based search.[8]ε-approximate nearest neighbor search is becoming an increasingly popular tool for fighting the curse of dimensionality. We then calculate the Euclidean distances d1 and d2 for both r and Θ of test image and each and every image in the database.

4. RESULTSAND DISCUSSIONS

The hand pattern images are given in Fig.4, the cropped image database is given in Fig.5, gray scaled and equalized database is given in Fig.6, thresholded database is given in Fig.7, filtered database is given in Fig.8 and thinned database is given in Fig.9. False acceptance rate and false rejection rate are two parameters considered as evaluation parameters.

4.1 False Rejection Rate

False rejection rate refers to the total number of authorized persons not getting access tothe system over the total number of people attempting to get the system. The false reject rate (FRR) is a measure of the probability that a biometric system will incorrectly reject an input as a negative match.We have found that out of the 80 images which are in the database, 3 images are falsely rejected. Also these 3 images are the duplicates of the ones present in the database.

Therefore,

FRR = (3 / 80) * 100 = 3.75 %---(3)

4.2 False Acceptance Rate

False acceptance rate (FAR) is a measure of biometric accuracy, it refers to the total number of unauthorized persons getting access to the system over the total number of people attempting to the system. It represents the probability that a given biometric system will accept an incorrect input as a positive match.We have found that out of the 20 images which are not in the database, 4 images are falsely accepted.

Therefore,

FAR = (4 / 20) * 100 = 20 %---(4)

Which means this proposed methodology is successful with an accuracy of 96.25%.Table 1 gives the Euclidean distances of images and training set, and Table 2 gives the false acceptance rate and false rejection rates.

Table 1: Euclidean distances of images and training set

S. No.	*Image No.*	*d1*	*d2*	*In Data Base*	*Result: Image found /not found*
1.	Imgl1_1	55	21	Yes	Found
2.	Imgl2	169	152	No	Not found
3.	Imgl3	144	34	No	NotFound
4.	Imgl4_1	100	97	Yes	Not Found
5.	Imgl5_1	86	37	Yes	Found
6.	Imgl6_1	30	53	Yes	Found
7.	Imgl7_1	14	40	Yes	Found
8.	Imgl8_1	64	50	Yes	Found
9.	Imgl9_1	25	26	Yes	Found
10	Imgl10_1	50	42	Yes	Found
11	Imgl11_1	50	28	Yes	Found
12	Imgl12_1	41	53	Yes	Found
13	Imgl13_1	31	60	Yes	Found
14	Imgl14	44	139	No	Not Found
15	Imgl15_1	60	41	Yes	Found
16	Imgl16_1	32	48	Yes	Found
17	Imgl17_1	34	27	Yes	Found
18	Imgl18_1	39	28	Yes	Found
19	Imgl19_1	116	68	Yes	Not Found
20	Imgl20_1	64	60	Yes	Found
21	Imgl21_1	56	77	Yes	Found
22	Imgl22_1	26	32	Yes	Found
23	Imgl23_1	58	60	Yes	Found
24	Imgl24_1	13	29	Yes	Found
25	Imgl25_1	29	68	Yes	Found
26	Imgl26_1	36	34	Yes	Found
27	Imgl27	39	17	No	Found
28	Imgl28	144	28	No	Not Found
29	Imgl29_1	100	24	Yes	Not Found
30	Imgl30_1	26	24	Yes	Found
31	Imgl31_1	26	32	Yes	Found
32	Imgl32_1	27	41	Yes	Found
33	Imgl33_1	54	35	Yes	Found
34	Imgl34	167	53	No	Not Found
35	Imgl35_1	59	23	Yes	Found
36	Imgl36	32	139	No	Not Found
37	Imgl37_1	11	17	Yes	Found
38	Imgl38	146	49	No	Not Found
39	Imgl39_1	25	73	Yes	Found
40	Imgl40	159	34	No	Not Found
41	Imgl41	31	135	No	Not Found
42	Imgl42_1	17	49	Yes	Found
43	Imgl43_1	58	37	Yes	Found
44	Imgl44	20	143	No	Not Found
45	Imgl45_1	49	77	Yes	Found
46	Imgl46_1	58	42	Yes	Found
47	Imgl47	152	42	No	Not Found
48	Imgl48_1	23	70	Yes	Found
49	Imgl49	30	127	No	Not Found
50	Imgl50	71	72	No	Found
51	Imgl51_1	30	31	Yes	Found
52	Imgl52_1	59	26	Yes	Found
53	Imgl53_1	22	50	Yes	Found
54	Imgl54	122	20	No	Not Found
55	Imgl55	134	44	No	Not Found
56	Imgl56_1	49	48	Yes	Found
57	Imgl57	31	18	No	Found
58	Imgl58	129	31	No	Not Found
59	Imgl59_1	47	35	Yes	Found
60	Imgl60_1	40	46	Yes	Found
61	Imgl91_1	24	56	Yes	Found
62	Imgl92	31	36	No	Found
63	Imgl93_1	58	58	Yes	Found

64	Imgl94_1	34	34	Yes	Found
65	Imgl95	136	43	No	Not Found
66	Imgl96_1	71	39	Yes	Found
67	Imgl97_1	75	34	Yes	Found
68	Imgl98_1	23	35	Yes	Found
69	Imgl99_1	69	61	Yes	Found
70	Imgl00_1	68	69	Yes	Found
71	Imgl1	0	0	Yes	Found
72	Imgl4	0	0	Yes	Found
73	Imgl5	0	0	Yes	Found
74	Imgl6	0	0	Yes	Found
75	Imgl7	0	0	Yes	Found
76	Imgl8	0	0	Yes	Found
77	Imgl9	0	0	Yes	Found
78	Imgl10	0	0	Yes	Found
79	Imgl11	0	0	Yes	Found
80	Imgl12	0	0	Yes	Found
81	Imgl13	0	0	Yes	Found
82	Imgl15	0	0	Yes	Found
83	Imgl16	0	0	Yes	Found
84	Imgl17	0	0	Yes	Found
85	Imgl18	0	0	Yes	Found
86	Imgl19	0	0	Yes	Found
87	Imgl20	0	0	Yes	Found
88	Imgl21	0	0	Yes	Found
89	Imgl22	0	0	Yes	Found
90	Imgl23	0	0	Yes	Found
91	Imgl24	0	0	Yes	Found
92	Imgl25	0	0	Yes	Found
93	Imgl26	0	0	Yes	Found
94	Imgl29	0	0	Yes	Found
95	Imgl30	0	0	Yes	Found
96	Imgl31	0	0	Yes	Found
97	Imgl32	0	0	Yes	Found
98	Imgl33	0	0	Yes	Found
99	Imgl35	0	0	Yes	Found
100	Imgl37	0	0	Yes	Found

Table 2: False acceptance rate and false rejection rate

Acceptance Rate	100%
False Acceptance Rate	20%
False Rejection Rate	3.75%

Fig.4 Image database

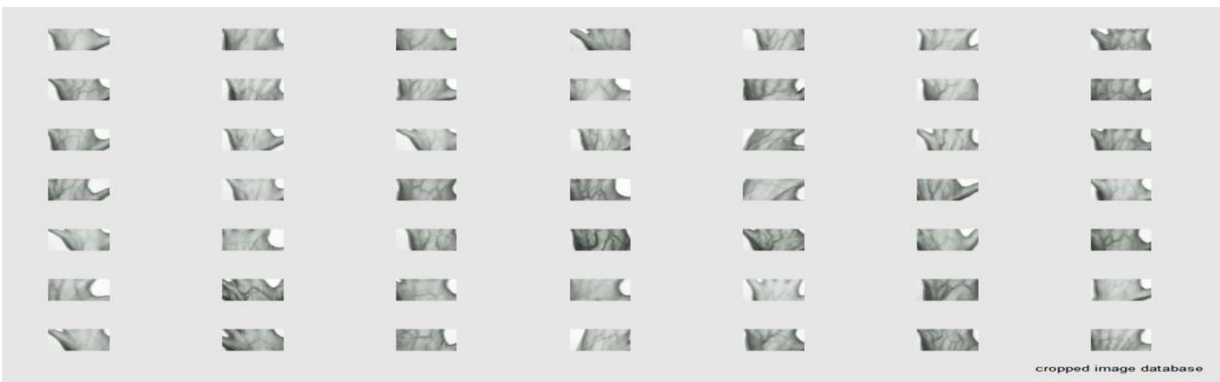

Fig.5 Cropped image database

Fig.6 Gray-scale and adaptive histogram equalized image database

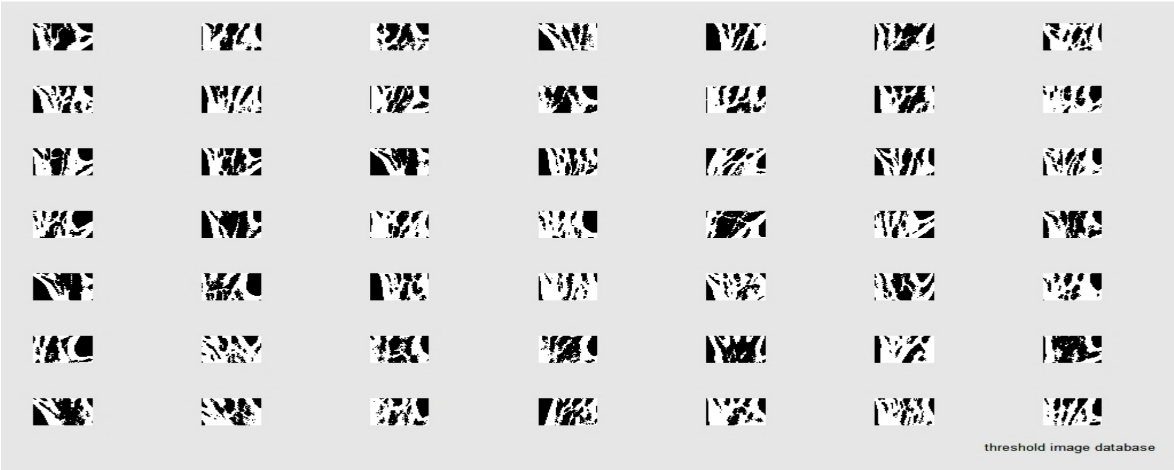

Fig.7 Threshold image database

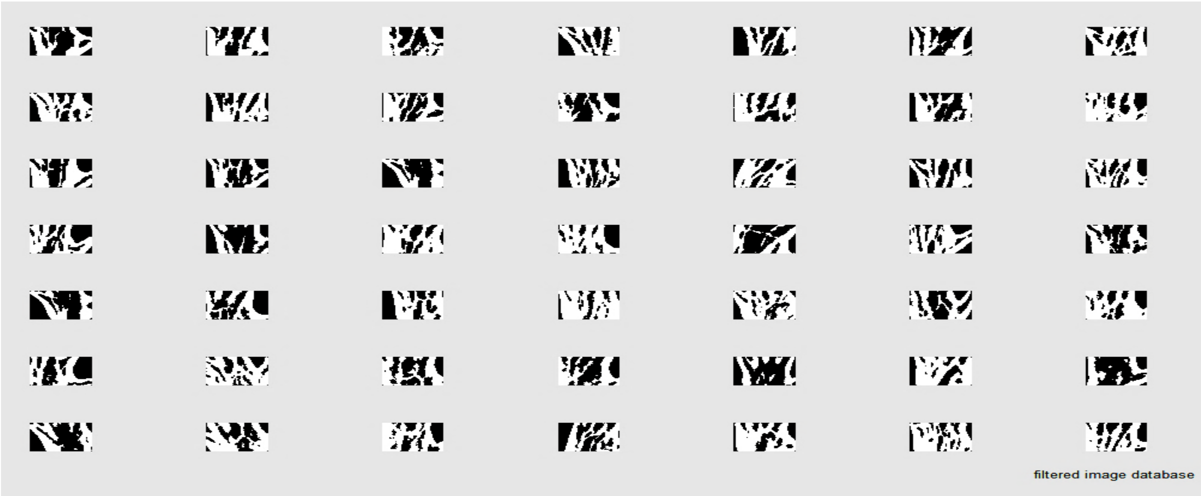

Fig.8 Filtered image database

Fig.9 Thinned image database

5. CONCLUSIONS

The system was tested over a dataset consisting of 70 persons of different age and gender for each 2 left hand images. In this proposed work, hand vein images were pre-processed. In the pre-processing the Croppingof the images has highlighted the vein patterns. The noise filtering and thinning of the training set has removed the undesirable noise components in the database as well as query image. Next Hough transform was applied on the database to extract the features.The resulting features namely, r and θ of the Hough peaks were stored in the database, which became the training set.The same procedure was applied for the query image to check for the authentication, based on the degree of similarities by using the KNN searching algorithm.We calculated the Euclidean distance between each r and θ of image database and the test image. Then we found out the minimum of the value the above distances d1 and d2.Then we fixed a threshold value for these distances and authenticate the person.By following this procedure we have come up with 96.25% accuracy with a False Acceptance rate of 20% and False rejection rate of 3.75%

REFERENCES

[1] Badawi.A.M, June 26-29, 2006, “Hand Vein Biometric Verification Prototype: A Testing Performance and Patterns Similarity” In Proceedings of the 2006 International Conference on Image Processing, Computer Vision, and Pattern Recognition (IPCV'06: Las Vegas, USA,PP 3-9.

[2] Chih- Lung Lin, Kuo-Chin Fan, Feb 2004, “Biometric Verification Using Thermal Images of Palm- Dorsa Vein Patterns”, IEEE Transactions on Circuits and Systems for Video Technology, VOL.14, NO.2, PP 199-213.

[3] D.H.Ballard,1981 “Generalizing the Hough transform to detect arbitrary shapes”,Pattern recognition, vol.13, No.2,pp 111-122.

[4] Im.S.K, Park.H.M, Kim.S.W, Chung.C.K, and Choi.H.S, June 2000, “Improved Vein Pattern Extracting Algorithm And Its Implementation”, in Digest of technical papers of International Conference on Consumer Electronics, PP 2-3.

[5] Jain.A.K, Ross.A and Prabhakar.S, January 2004, “ An Introduction to biometric Recognition”, IEEE Transactions on circuits and systems for Video Technology, Vol 14, No 1,PP 4-20.

[6] Ratha.N.K, Senior. A, and Bolle.R.M, March 2001, “Tutorial on Automated Biometrics” in Proceedings of International Conference on Advances in Pattern Recognition, Rio de Janeiro, Brazil, PP 445-474.

[7] Shi Zhao, Yiding Wang and Yunhong Wang, 2007 “Extracting Hand Vein Patterns from Low-Quality Images: A New Biometric technique Using Low-Cost Devices”, IEEE, 4th International Conference on Image and Graphics,PP 667-671.

[8] Larose, D. T. (2005) k-Nearest Neighbor Algorithm, in Discovering Knowledge in Data: An Introduction to Data Mining, John Wiley & Sons, Inc., Hoboken, NJ, USA.

[9] Tanaka.T, and Kubo.N, Aug 4-6, 2004, “Biometric Authentication by Hand Vein Patterns”, SICE Annual Conference in Sapporo, PP 249-253.