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The Effect of Varying Resolution on the Recognition Performance of a Palm Vein Recognition System

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Abstract: Palm vein recognition is one of the most desirable biometric identification techniques. It is also an important area in image processing and pattern recognition field. Several researches have been carried out on palm vein which has led to the proposition of different techniques. This paper investigates the effect of varying resolution on the recognition performance of a palm vein system. The performance of the system was evaluated based on different image resolution, different training datasets, recognition time and recognition accuracy. The system gave percentage recognition of between 22%-99% at image resolutions of 10×10 and 50×50. FAR and FRR were between 2.5%-12.5% and 1%-78%. EER was 11.83% at 43.18 pixels resolution. It was deduced from the research that image resolution has a great influence on the recognition performance of a palm vein system.

Keyword: Keywords: Principal Component Analysis and Self-Organizing Map

1. Introduction

Palm vein authentication is one of the vascular pattern authentication technologies. Vascular pattern authentication includes vein pattern authentication using the vein patterns of the palm, back of the hand or fingers as personal identification data, and retina recognition using the vascular patterns at the back of the eye as personal identification. Since everyone has vessels, vascular pattern authentication can be applied to almost all people. If vascular patterns were compared to the features used in other biometric authentication technologies, such as the face, iris, fingerprint, voice, and so on, the only difference would be whether or not the feature is at the surface of the body. Consequently, vascular patterns cannot be stolen by photographing, tracing, or recording them. This means that forgery would be extremely difficult under ordinary conditions (Masaki Watanabe, www.tiburon-ent.com).

Palm vein authentication has a high level of authentication accuracy due to the uniqueness and complexity of vein patterns of the palm. The palm vein patterns are internal to the body; which makes it difficult to forge. Also, the technology is hygienic for use in public areas. It is more powerful than other biometric authentication such as face, iris, and retinal. Palm vein authentication uses an infrared beam to penetrate the users hand as it is held over the sensor; the veins within the palm of the user are returned as black lines. (Ishani et al, 2010). This paper hybridized Principal Component Analysis and an unsupervised neural network usually used for clustering data i.e. Self-Organizing Map together, so that an output of the PCA, is an input to the SOM algorithm to investigate the effect of varying resolution of the recognition performance of a palm vein system.

2. Literature Review

Yi-Bo et al, 2007 developed a scheme for personal authentication using palm vein. The infrared palm images which contained the palm vein information were used for the system. The system provides personal authentication and liveness detection concurrently because the vein information represents the liveness of a human. The system was in three phases: Infrared palm images capture; Detection of Region of Interest and palm vein extraction by multi-scale filtering and matching. The experiment results demonstrated that the recognition rate using palm vein is good. Shi et al, 2007, proposed a biometric technique using hand-dorsa extracting vein structures. For conventional algorithm, it is necessary to use high-quality images, which demand high-priced collection devices. The proposed method makes use of a low-cost devices and able to extract vein image. The results showed that the low cost device could extract the vein pattern networks successfully as using high-quality images.

Masaki et al, 2005 have shown a biometric authentication using contactless palm vein authentication device that uses blood vessel patterns as a personal identifying factor. Implementation of these contactless identification systems enables applications in public places or in environments where hygiene standards are required, such as in medical applications. In addition, sufficient consideration was given to individuals who are reluctant to come into direct contact with publicly used devices. The application of vein detection concept to automate the drug delivery process was studied by Kavitha and Little, 2011.

The experiment deals with extracting palm dorsal vein structures, which was a key procedure for selecting the optimal drug needle insertion point. Gray scale images obtained from a low cost IR-webcam are poor in contrast, and usually noisy which make an effective vein segmentation a great challenge. Here a new vein image segmentation method was introduced, based on enhancement techniques resolves the conflict between poor contrast vein image and good quality image segmentation. Gaussian filter was used to remove the high frequency noise in the images. The ultimate goal was to identify venous bifurcations and determine the insertion point for the needle in between their branches was achieved.

3. Methodology

An image can be viewed as a vector of pixels where the value of each entry in the vector is the gray scale values (0-255) of the corresponding pixel. For instance, an 8*8 image may be unwrapped and treated as a vector of length 64. The image is said to be in N-dimensional space, where N is the number of pixels (and the length of the vector). This vector representation of the image is considered to be the original space of the image.

3.1 Stages in the Development of the Proposed System

The required stages involved in the development of the proposed system are highlighted below:

STAGE1: Image Acquisition

Data acquisition is the first stage of any pattern recognition process. It is the process that involves the sampling of biometric feature and the conversion of these features into the form that can be manipulated by the computer.

STAGE2: Palm Vein Preprocessing

This stage prepares the acquired palm vein image for preprocessing. Preprocessing involves the following activities:

1) Scaling of Pictures

Palm vein images were cropped from its original captured sizes and were later resized from the original dimension of 480*480 to 200*200 pixels.

2) Cropping

The images were cropped to sizes of 10*10, 15*15, 20*20, 25*25, 30*30, 35*35, 40*40, 45*45, 50*50 pixels from the centre of the image by the program in order to test for the effect of varying resolution on the recognition performance.

3) Gray Scale Conversion

The cropped images in the database were converted into gray scale so as to make it suitable for the palm vein recognition system.

STAGE3: Feature extraction

This is the process of using the most important information of the cropped palm vein images for classification purpose. PCA algorithm was used to extract sufficient features that enhanced the recognition rate as shown in figure 1.

STAGE4: Training and Classification

Computed eigenpalms (eigenvectors) were ordered at this stage to form eigenspace. The centered training image vectors were then projected onto the eigenpalm space. Euclidean distance was used as a threshold to determine the class, the training and the testing image belong.

STAGE5: Recognition/Testing

Testing and recognition were performed using different image resolution and different training images per individual to determine performances under different image sizes as depicted in figure 2.

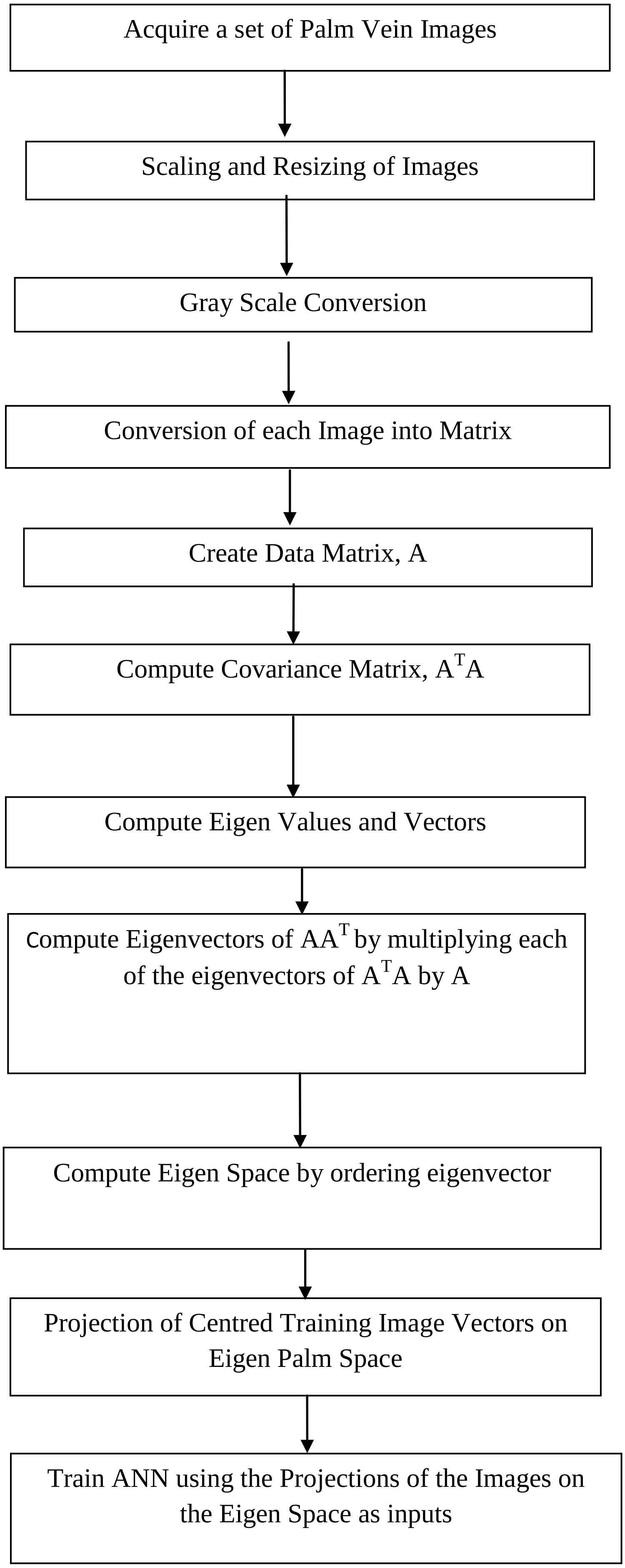

Fig.1 The Processes involved in the Training Stage of the System

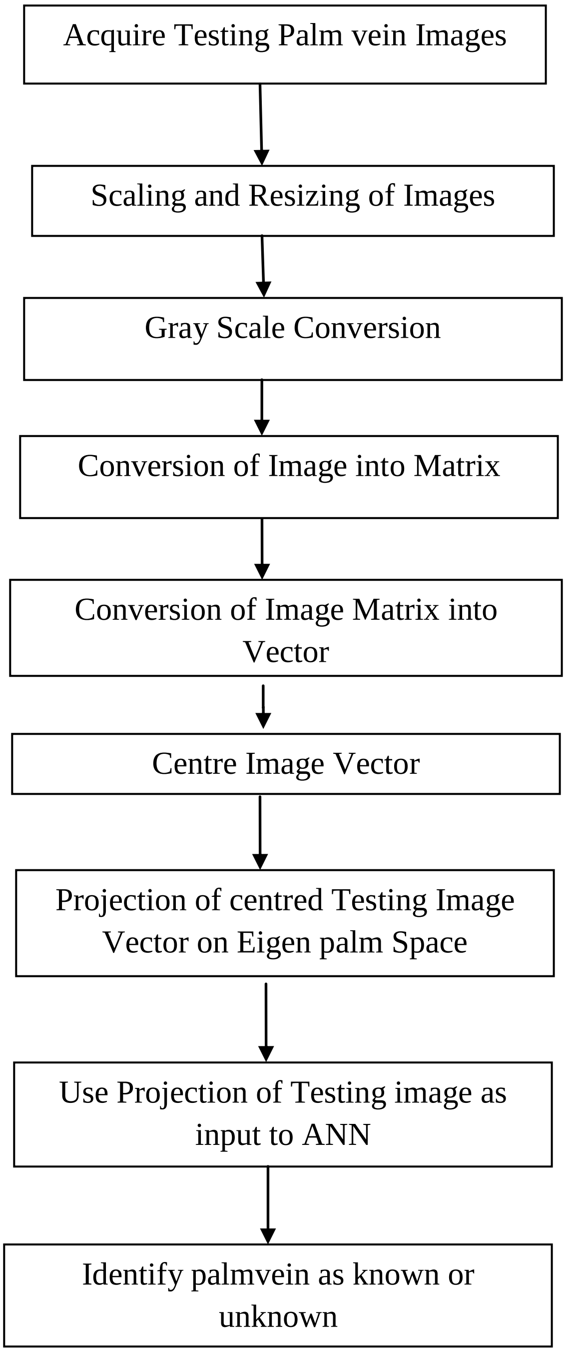

Fig.2 The Processes involved in the Testing Stage of the System

4. Experiments

The code implementing the palm vein recognition system was tested on a dual core system board with 2.2GHz processor speed. The experimental results got were basically limited by the medium level state of the computer system, palm vein scanner, different environmental conditions, and the quality of palm vein images. The palm vein database under consideration was developed entirely from the scratch and the facilities for proper palm vein alignment used were the ones at our disposal.

The palm vein recognition system was experimented with a total of 160 images, out of which 140 images were used in training the database and 100 images were used for testing the created database. This represents six images (four training and two testing) for 40 individuals representing a class each. The image resolutions of the captured images were then varied 10×10 to 50×50 to investigate the effect of varying resolutions on the recognition performance of the system.

Results and Discussion

The total number of unidentified images fairly reduces as the pixel resolution increases. This is on the ground that the more the palm vein features that are included in the training and testing images, the better the recognition performance. The palm vein features involved include; principal lines, wrinkles, delta points and minutiae .Also, experiments conducted revealed that percentage recognition accuracy increase from 22% to 99% due to its classification strength as shown in table 1.it was deduced from the result that performance goal of the neural network were met, which gave rise to reasonable percentage recognition accuracy.

In addition, further experiments were performed to determine the error rate for every resolution considered. This was done to investigate the scalability of the developed system in controlling access. Equal Error Rate (EER) which is used to represent the overall system accuracy, the resistance of the system to break-ins and the ability to match templates from authorized users were also investigated. The False Acceptance Rate (FAR) was 2.5%-12.5% and False Rejection Rate (FRR) was 22%-78% both at 0.0001 thresholds respectively as indicated in table 2. EER was 12.53% at 46.37 pixel resolution which is well depicted in figure 2.

TABLE 1: PARAMETERS CONSIDERED FOR THE SYSTEM

Resolution of Cropped Face Image	Total Number of Images used in Testing	Number of Unidentified Image	Time to train Palm Vein database (seconds)	Time to identify an image as known or Unknown (seconds)	Percentage Recognition rate (%)
10*10	100	78	70.700	4.577	22
15*15	100	72	76.678	5.337	28
20* 20	100	62	96.841	5.545	38
25*25	100	53	126.516	6.310	47
30*30	100	44	169.006	7.221	56
35*35	100	34	226.235	8.681	66
40*40	100	22	289.500	9.915	78
45*45	100	6	335.133	13.070	94
50*50	100	1	426.585	13.171	99

TABLE 2: FAR AND FRR OF THE SYSTEM AT AN EUCLIDEAN DISTANCE OF 0.0001

Resolution of Cropped Face Image	%FRR	%FAR
10*10	78	2.5
15*15	72	5
20* 20	62	5
25*25	53	7.5
30*30	44	7.5
35*35	34	10
40*40	22	10
45*45	6	12.5
50*50	1	12.5

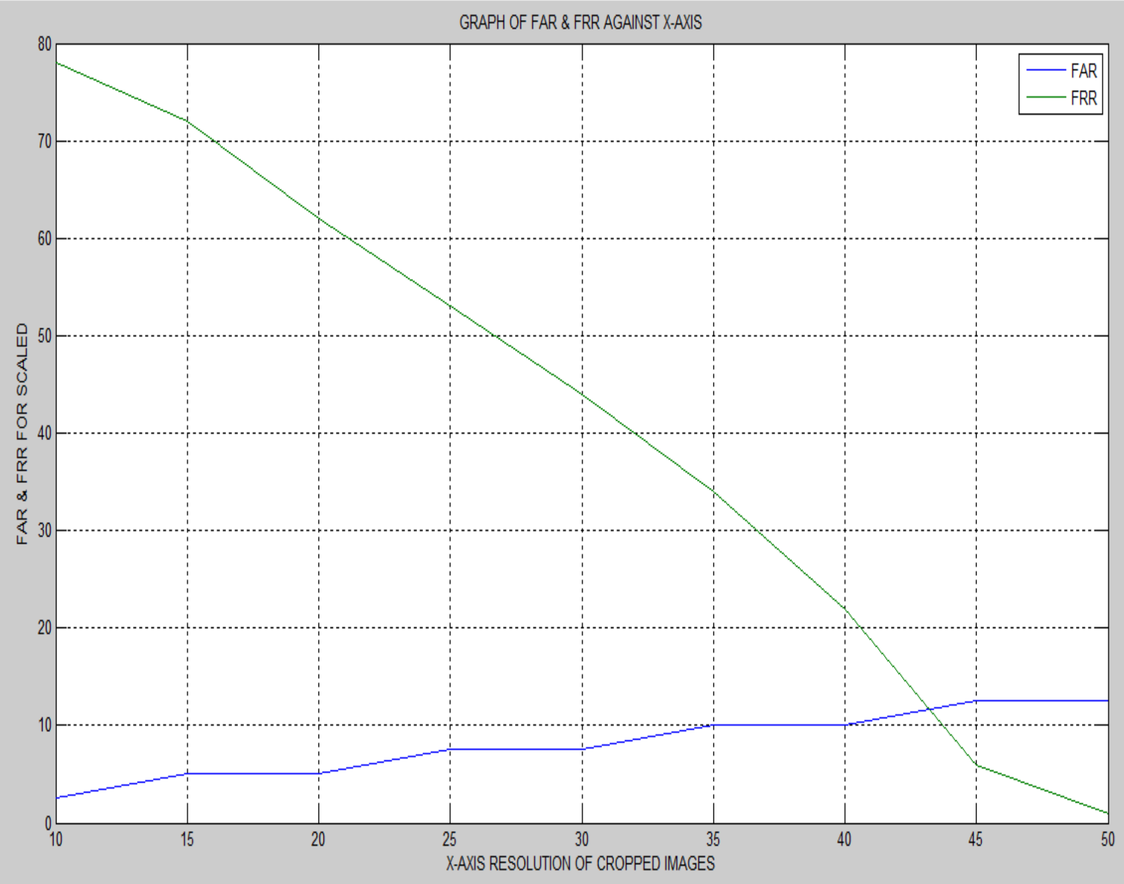

FIGURE 1: THE FALSE ACCEPTANCE RATE AND FALSE REJECTION RATE OF THE SYSTEM

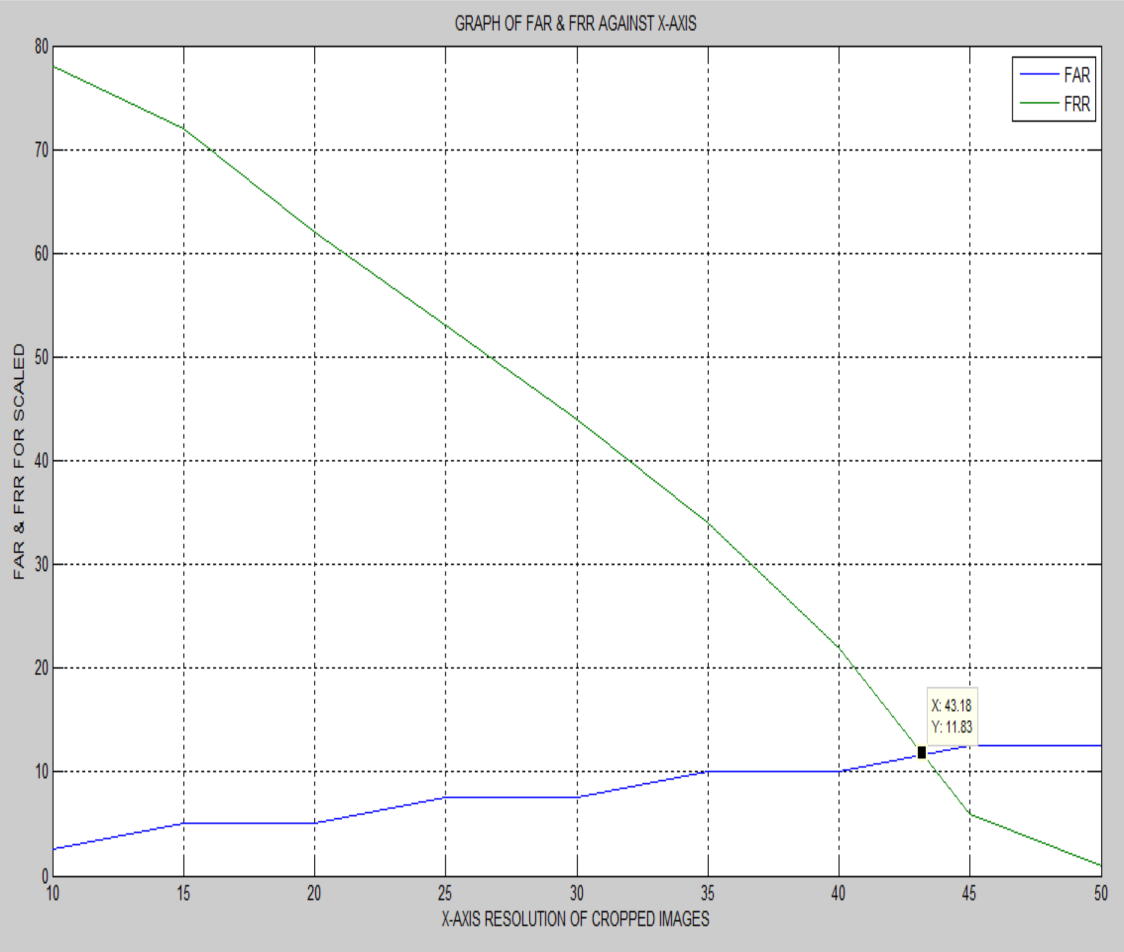

FIGURE 2: EQUAL ERROR RATE OF THE SYSTEM

5. Conclusion

The effect of varying resolution on the recognition performance of a palm vein system has been investigated. Principal Component Analysis and Self-Organizing Map have been used for dimension reduction and classifier respectively. It was deduced from the experiment that image resolution has a great influence on the recognition performance of a palm vein system.

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