EFFECT OF ENHANCING QUALITY OF ROI ON PALMPRINT AND PALM VEIN BIOMETRIC IDENTIFICATION

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Abstract: *Palm print and palm veins are unique biometric attributes, hence useful in biometric identification. Use of entire palm image involves large size and computations. So a Region of Interest ROI is cropped for extracting features and making automated decisions. The extracted ROI needs to be enhanced to highlight the dominant features. The amount of enhancement can be measured using quality attributes of an image. This paper presents a method for ROI enhancement, its quantification and effect on identification performance of biometric system based on palmprints and palm veins.*

Keywords: palmprint, palm vein, biometric, image quality, ROI, image enhancement

1. INTRODUCTION

Biometric identification systems are based on human biological features for confirming the identity of a person. They are used in security applications. Of the different biometrics, palm print and palm vein have advantages of uniqueness, stability and safety from spoof attacks [1].

To design the biometric system, the palm image has to be first captured and then it has to be subjected through digital image processing stages such as image preprocessing, extracting ROI, feature extraction and feature matching [2]. Pre-processing is carried out for segmentation, alignment, contrast enhancement and increasing the sharpness of the images so that the features become dominant and can be easily extracted [3]. This is followed by ROI extraction which involves selecting a sub image for feature extraction.

Certain post processing operations on the ROI are essential for normalization and reducing the effect of distortions. This paper gives an insight to the post processing of ROIs, quantifying the image enhancement and its effect on the performance of identification.

2. BASIC INFORMATION

During post processing, the ROIs are normalized to have specific mean and variance. If the gray level at (x, y) in a palm print image is represented by I(x, y), then mean and variance of the image, μ and ρ, respectively, can be computed. The normalized image I'(x, y) is computed using pixel wise operations as follows:

$I'(x, y) = \mu_d + \lambda$ if $I(x, y) > \mu$
$I'(x, y) = \mu_d - \lambda$ otherwise
Where $\lambda = \sqrt{\frac{\rho_d (I(x,y) - \mu)^2}{\rho}}$

where μ_d and ρ_d are the desired vales for mean and variance respectively [4].

Different types of filters, histogram equalization, and enhancement techniques are used to highlight prominent features in the ROIs. [5, 6]. Post processing is required to eliminate noise in the image. To achieve this, noise cleaning techniques are used. [7, 8]

To evaluate the amount of image enhancement resulting due to post processing, the entropy and Edge Acutance value of the extracted ROI and the sharpened ROI can be computed. Entropy is a measure of the information content in the ROI. It is a statistical measure of degree of randomness. ROI images with low entropy have less contrast whereas images with high entropy have high contrast [8 from below].

The gray level discontinuities in the palm ROIs are detected as edges in the images. The quality of the ROI can also be evaluated by measuring the image sharpness using the parameter of edge acutance value

$$EAV = \frac{\sum\sum Neighbor\ (x,y)}{mxn}$$

where $Neighbor(x,y) = \sum\sum \frac{I(x,y)-I(i,j)}{\sqrt{(x-i)^2+(y-j)^2}}$ [9]

3. METHODOLOGY

Palm images of 100 persons from CASIA Palmprint and Multispectral databases provided by Chinese Academy of Sciences' Institute of Automation have been used in this work. The ROIs are extracted and post processing is performed on them. The enhancement in ROIs is measured using image quality attributes of entropy and edge acutance value.

Appearance based features using Principal Component Analysis are extracted [10]. Feature matching is implemented using weighted Euclidean distance measure. The effect of post processing on identification accuracy is assessed by computing the Genuine Acceptance Rate (GAR) and Equal Error Rate (EER).

The algorithms have been implemented using MATLAB R2016 on an Intel ® core ™ i5-2400, 3.10 GHz CPU.

4. EXPERIMENTAL WORK

4.1. Post processing operations on ROI

The foremost step is to have all the ROIs of the same size with scale normalization. In this work the ROIs have been scaled to 150x150. This is followed by normalization with respect to mean and variance.

After normalizing the ROIs, median filtering is applied in a 3 by 3 neighbourhood around an image pixel. This helps to reduce the effect of salt and pepper noise.

The ROIs are sharpened to highlight the edges and fine details. This is implemented by subtracting the Laplacian derivative from the normalized ROI [11]. The Laplacian filter is a gradient filter which enhances the gray level discontinuities in the ROI.

Figure 1 shows the post processing implemented to obtain sharpened palmprint ROIs on three sample images from CASIA Multispectral database. The same algorithms have been implemented for palm vein images of CASIA Multispectral database. Figure 2 shows the processing operations on sample three palm vein ROIs.

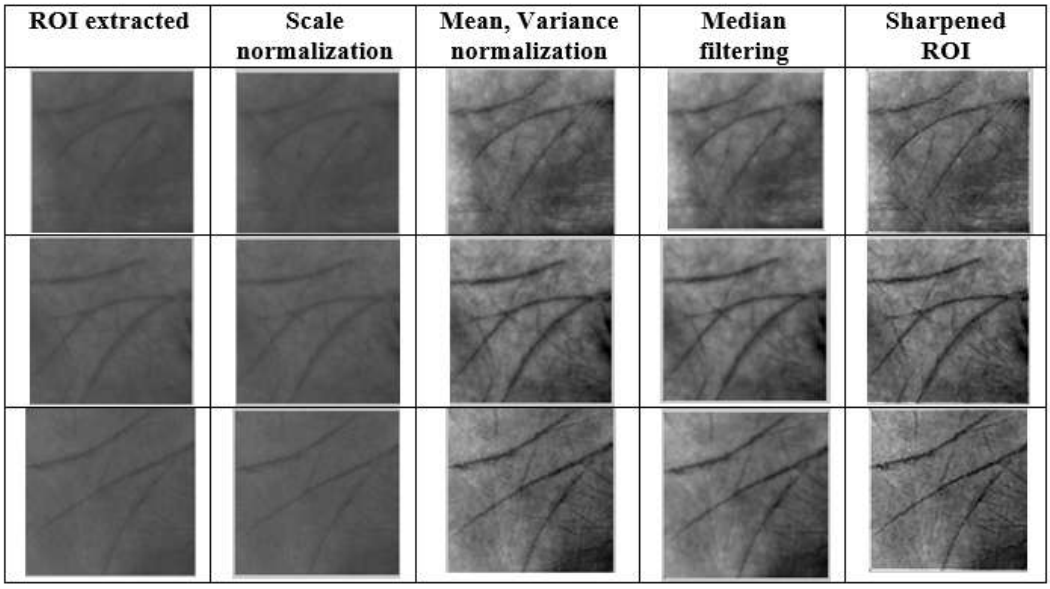

Figure 1. Enhancement of Palmprint Images ROI

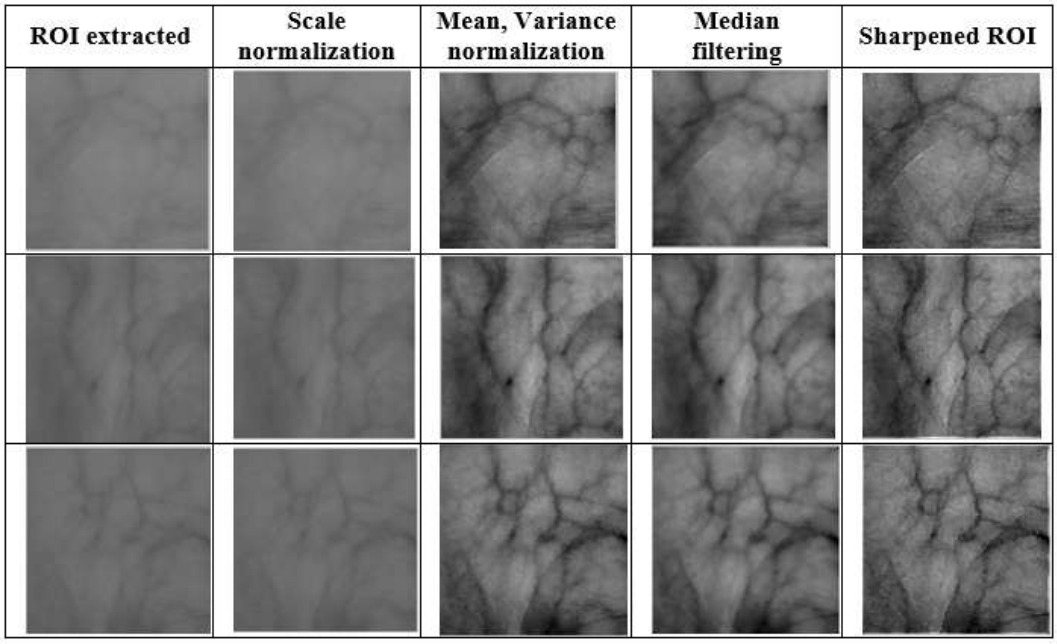

Figure 2. Enhancement of Palm vein Images ROI

4.2. Evaluating quality parameters of ROI:

The effect of post processing operations have been evaluated in terms of quality of ROIs by measuring the entropy and Edge Acutance value of the extracted ROI and the sharpened ROI. The entropy and edge acutance parameters of extracted and sharpened ROIs have been computed. The minimum, maximum, mean and standard deviation of these values are provided in table 1.

Table 1.Table Label

Images	ROI	Entropy				Edge Acutance Value			
		Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation
Palm-print	Extracted	4.43	6.29	5.34	0.32	3.8	11.21	7.32	1.25
	Sharpened	7.11	7.74	7.39	0.12	13.11	19.65	16.76	1.15
Palm Vein	Extracted	3.8	6.0	4.99	0.34	5.02	10.63	7.93	0.89
	Sharpened	6.54	7.52	7.17	0.12	13.81	19.33	16.61	1.01

4.3. Performance evaluation

To estimate the effect of sharpening on ROIs, the ROIs before sharpening but normalized are considered for biometric identification. Principal Component Analysis is used to extract the feature vector and weighted Euclidean distance for feature matching to decide on match or no match. Same procedure is repeated for enhanced and sharpened ROIs obtained as explained in section 4.1. Biometric system performance parameters of Genuine Acceptance Rate (GAR) and Equal Error Rate (EER) are obtained. The results obtained are given in table 2.

Table 2. Performance parameters with ROI enhancement

Biometric type	Performance	Before sharpening of ROI	After sharpening of ROI
Palmprint images	GAR (%)	92.4	96.3
	EER (%)	3.8	1.7
Palm vein images	GAR (%)	95.2	97.3
	EER (%)	2.4	1.3

5. RESULTS AND DISCUSSION

The post processing operations for enhancing the ROIs involve the steps for normalization and sharpening of the ROIs to enable feature extraction. The quality of the resultant ROIs has been quantified with the parameters of entropy and edge acutance value. The values in table 1indicate that there is a marked improvement in the quality of ROIs after sharpening.

The effect of normalised and enhanced ROIs are examined with PCA feature extraction and weighted Euclidean distance feature matching. There is improvement in the performance parameters for identification both in case of palmprint and palm vein biometrics.

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