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A Novel Gaussian Measure Curvelet Based Feature Segmentation and Extraction for Palmprint Images

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Abstract

Objectives: An effective feature extraction and segmentation model is employed for palm print images to improve accuracy, computation efficiency and robustness of palm print features. **Methods/Analysis:** The novel Gaussian Measure Curve let based Feature Segmentation and Extraction (GMC-SE) method is introduced for removal of unwanted execution time by using Edge Based Tangent (EBT) model. In addition, to improve the computation efficiency of features being segmented, competent Gaussian measure is obtained by integrating both local and global palm print features. **Findings:** Experiment is conducted using Poly U 2D palm print database to measure the effectiveness of the proposed work in terms of execution time ratio, computation efficiency, feature extraction accuracy and robustness in palm print recognition. The proposed scheme GMC-SE method is compared against the existing Fine Ridge Structure Dictionary (FRSD) and Personal Identification using Left and Right Palm Print images (PI-LRPP). As a result, the GMC-SE method improves the computation efficiency by 12% compared to existing FRSD model. **Conclusion/Application:** An effective feature extraction and segmentation are analyzed for palm print images and experimental results are compared. GMC-SE method for palm print images handled different images in an efficient manner compared to existing works.

Keywords: Edge based Tangent Model, Gaussian Measure Curvelet based Segmentation, Palmprint Images, Palm Segmentation

1. Introduction

Biometric applications described an individual is based on the physical or behavioral characteristics. Several biometric characteristics such as fingerprints, palm print, hand geometry, iris, retina, face, hand vein, facial thermo gram, signature, voice, etc. used by various research communities. Palm line patterns play an important role in determining the individuals as it maintain more features where access control is necessary.

Fine Ridge Structure Dictionary (FRSD)[1] applied total variation model and dictionary based approach to balance robustness and accuracy while segmenting latent images. But, lack of confidence on robust patch quality compromised the computation efficiency of palm print images. Personal Identification using Left and Right Palm Print images (PI-LRPP)[2] combined both left and right palm print images to improve the matching score level fusion. But time to obtain the features was not considered.

Personnel authentication with the aid of automatic model using features obtained through biometric in a wide manner over the last two decades. Moreover, different works have also been focused and concentrated on biometric systems for security concerns or commercial purposes. Symbolic Aggregate Approximation (SAX)[3] was presented in a significant manner to provide palm print authentication and solved certain issues related to pattern recognition.

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Segmented Circular Strip (SCS) was applied in[4] in order to provide robustness not only to orientation but also extracted accurate palm print features. However, the overall accuracy of the matching process remained unaddressed. To improve the accuracy, Phase Symmetry (PS)[5] was applied between training and test images.

About 30 percent of the latents obtained through crime scenes are extracted through palm print images. Minutiae propagation algorithm presented in[6] introduced mechanisms for minimizing the computation time for efficient palm print matching. However, the features considered were in small amount which was solved by applying several features including principle lines, ridges, minutiae points and textures. Robust key point detection using Scale Invariant Feature Transform (SIFT)[7] improved the retrieval rate when applied to palm print images. However the computational cost involved during the retrieval also increased with the increase in the size of images. However, accuracy was compromised which has been introduced in our work using double hashing procedure.

In SIFT based Finger-Knuckle-Print (FKP) authentication systems, the storage and computational cost will directly depend on the size of the feature descriptors used. Such matching process will directly match these feature descriptors to find an exact match and the descriptors were directly stored in storage media as templates[8].

In sonar images among all filters, hybrid of SRAD and Gaussian Filter in spatial domain proves best for the filtering of speckle noise[9].

Based on the aforementioned techniques and methods, an efficient Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) using palm print images are presented in the forthcoming section.

2. Overview of Gaussian Measure Curvelet based Feature Segmentation and Extraction for Palm Print Images

Palm print based biometric system is potentially a good choice for biometric applications due to its rich features, including geometric features, line features, point features, texture features statistical features and so on. We investigate an efficient Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) of palm print images to improve the accuracy and robustness of palm print identification system.

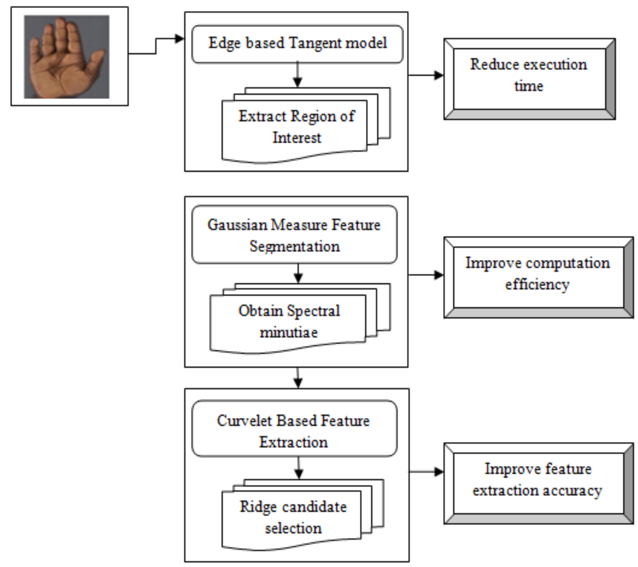

Figure 1. Architecture of GMC-SE.

The design of GMC-SE is split into three parts (Figure 1). The first part concentrates on preprocessing of palm print images using Edge Based Tangent model. With the aid of EBT model, the regions of interest are obtained. This results in the execution time reduction or removal of distortions in the images. The second part focuses on the segmentation of features from the preprocessed images. Effective segmentation of features is performed by applying Gaussian Measure Feature Segmentation. The application of GMFS model improves the computation efficiency by obtaining the spectral minutiae based on the local and global features.

Finally, efficient feature extraction is performed through Curvelet based model by extensive selection of ridge candidates which results in feature extraction accuracy. The elaborate details of GMC-SE are explained in the forthcoming sections.

2.1 Design of Edge based Tangent Model

The first step in the design of Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) using palm print images is to perform an efficient preprocessing to reduce the unwanted distortions, extract the region of interest to be considered for performing feature segmentation.

In this work, an efficient Edge Based Tangent Model is applied that significantly extracts the edges of principal line (i.e., outside and topside of a palm) on the palm print images is presented that significantly reduces the execution time present in palm print images. Preprocessing of palm print images using EBT model is shown in Figure 2.

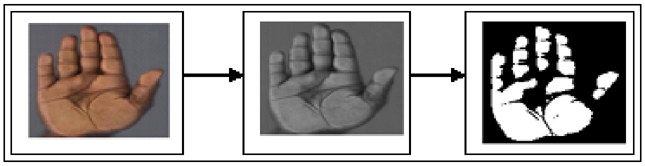

Figure 2. Preprocessing using Edge Based Tangent Model.

The common tangent of the two principal lines involving outside and topside of a palm is considered to be the region of interest. The key points for the two principal lines are measured as the midpoint of the two tangent principal lines.

Let us consider a palm print image $Image_n$ with $A*B$ dimension and $Image(a, b)$ represents the pixel in palm print image $Image_n$. Then the midpoint of the two tangent principal lines using Edge based Tangent Model is given as follows:

$$ET = \frac{b_2(i) - b_1(i)}{a_2(i) - a_1(i)} \quad (1)$$

From (1), a_1, $a_2 b_1$, b_2, represents the two tangent, tangent a and tangent b principal lines of palm print image. The resultant midpoint of two tangent principal lines obtained from (1) on the basis of the coordinate system is then extracted for feature segmentation.

2.2 Construction of Gaussian Measure Feature Segmentation

The second step in the design of Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) using palm print image is to perform an efficient segmentation process to improve the computation efficiency. Once the preprocessing of palm print images is accomplished, the resultant midpoint of two tangent principal lines is then segmented. This is performed using Gaussian Measure Feature Segmentation (GMFS) model by integrating both local and global palm print features as shown in Figure 3.

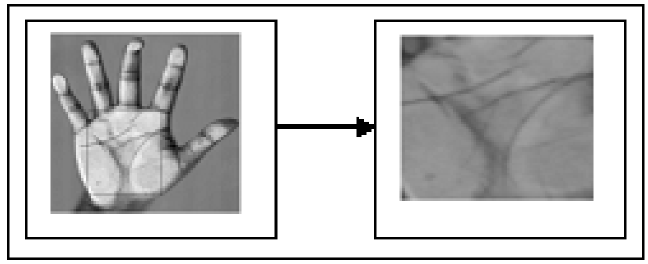

Figure 3. Obtain region of interest.

Gaussian Measure Feature Segmentation uses square regions for effective segmentation of high resolution palm print images. Given the minutia set, the features are then segmented using Gaussian measure by evaluating the spectral minutiae in the square regions and is formulated as given below;

$$SM\,(P,Q) = \frac{1}{(2n+1)^2} \sum_{a=1}^{n} \sum_{b=1}^{n} Image\,(a,b) \quad (2)$$

From (2), the spectral minutiae for two sample minutiae points P and Q in the square regions of dimensions $A * B$ are given. The two end points E_1 *and* E_2 are then detected based on the Gaussian Measure that first extracts the mid position as given below;

$$MP^{E_1,E_2} = MAX\,\left|P(a,b), Q(a-i, b-i)\right| \quad (3)$$

From (3), $Q(a - i, b - i)$ denotes the shift scaling for $Q(a, b)$ where shift scaling of a (i.e., local) represents the radical movement of scaling and b (i.e., global) represents the angular movement. From the midpoint obtained from (3), each palm print is segmented into two regions by considering line segment (a, b) as boundary lines. This in turn improves the computation efficiency for segmenting high resolution palm print images. These regions are then used to extract the features.

2.3 Design of Curvelet based Feature Extraction Model

The third step in the design of Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) is to apply an extensive feature extraction method. The

GMC-SE applies Curvelet Based Feature Extraction model for effective extractions of features using palm print image to enhance the feature extraction accuracy. Feature extraction using GMC-SE is performed through the segmented regions by considering three minute lines that extracts the exact texture of palm print images enhancing the accuracy of features being extracted.

Curvelet Based Feature Extraction model initially extracts the ridge candidate from the segmented regions. The ridge candidate is transformed into small minute curvelet regions where different ridge candidates present in the segmented palm print images are obtained with the aid of local features. During ridge candidate selection, global features are also used to obtain the local features present in global portion. Now, both the local features and the local features from the global portion are also extracted using curvelets and is given as below;

$$C(a,b,\theta)[L] = (Image_n, \mu_{a,b,\theta}) \quad (4)$$

$$C(a,b,\theta)[G] = (Image_n, \mu_{a,b,\theta}) \quad (5)$$

From (4) and (5), the curvelet based feature extraction for both local and global features is performed for '*n*' images on the basis of '*a*' scaling, '*b*' angular movement and '*θ*' orientation respectively.

Finally, both the local and global feature are thinned and extracted by restructuring the coefficient matrices of each palm print images into a row matrix. Each row matrix of training palm print images now results in a resultant product matrix, denoted as the best features to be extracted, therefore improving the feature extraction accuracy. The algorithmic description of GMC-SE is given below.

Input: Palm print images
Output:
Step 1: Begin
Step 2: For each Image
Step 3: Apply Edge Based Tangent Model to palm print images
Step 4: Perform preprocessing using (1)
Step 5: Apply Gaussian Measure Feature Segmentation to preprocessed images
Step 6: Obtain region of interest from (2) and (3)
Step 7: Perform Curvelet based Feature Extraction
Step 8: Extract both local and global features using (4) and (5)
Step 9: end for
Step 10: end

Algorithm 1-Algorithmic description for GMC-SE.

The three main steps followed in the design of GMC-SE for palm print images are given above as algorithmic description. The algorithm first starts with the application of EBT model to palm print images. Next, with the preprocessed images obtained, the region of interest is obtained through spectral minutiae and midpoints. With the obtained spectral minutiae and midpoints, Gaussian measure is applied to perform efficient segmentation. Finally, local and global features are extracted with the application of Curvelets to improve the feature extraction accuracy.

3. Experimental Evaluation

To evaluate the efficiency and scalability of the method, Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) using palm print images, extensive performance study is done. In this section, we report our experimental results on the performance of Fine Ridge Structure Dictionary (FRSD)[1] and Personal Identification using Left and Right (PI-LRPP)[2] Palm Print images. All the experiments were performed on a 466 MHz Pentium PC machine with 128 Mb main memory and 20Gb hard disk, running Microsoft Windows/NT. GMC-SE was simulated using MATLAB and the results were evaluated with the aid of Poly U 2D palm print database.

In order to test our proposed method GMC-SE, we perform experiments on the Poly U 2D Palmprint Database. The Poly U 2D Palmprint Database includes 8000 samples collected from 400 different palms. Twenty samples from each of these palms were collected in two separated sessions, where 10 samples were captured in each session, respectively. 500 samples of 50 different samples (10 samples of each palm) are chosen as the experimental database from the Poly U 2D Palmprint Database. This paper used the Poly U 2D Palmprint Database and by using the GMC-SE method, the experiment is conducted to measure and evaluate on the factors such as execution time during preprocessing, computation efficiency and feature extraction accuracy.

4. Discussion

Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) for palm print images is compared against the existing Fine Ridge Structure

Dictionary (FRSD)[1] and Personal Identification using Left and Right Palm Print images (PI-LRPP)[2].

4.1 Measure of Execution Time during Preprocessing

Execution time during preprocessing using GMC-SE measures the time taken to preprocess the palm print images. It is measured in terms of milliseconds (ms). The formulation of execution time is given as below;

$$Exec\ Time = Time\ (No.of\ images) \tag{6}$$

The execution time for preprocessing the palm print images of our method and comparison made with two other existing schemes namely, Fine Ridge Structure Dictionary (FRSD)[1] and Personal Identification using Left and Right Palm Print images (PI-LRPP)[2] is listed in Table 1.

Table 1. Tabulation for execution time

No. of Images	Execution Time (ms)		
	GMC-SE	FRSD	PI-LRPP
20	11	17	19
40	29	37	45
60	35	45	59
80	43	52	65
100	40	49	60
120	52	62	68
140	60	71	69

Figure 4 illustrates the execution time for preprocessing the palm print images using Poly U 2D Palmprint Database for performing efficient palm print identification and recognition. Our proposed method, Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) performs relatively well when compared to two other methods (FRSD)[1] and (PI-LRPP)[2].

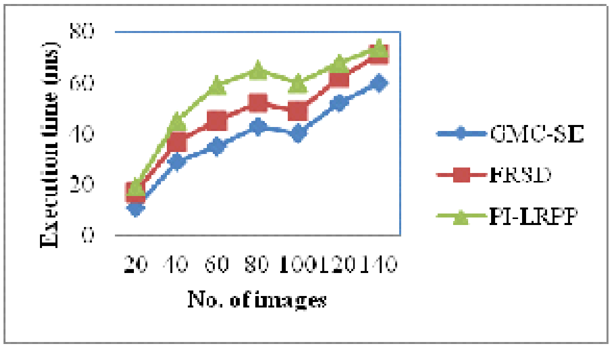

Figure 4. No. of images versus execution time.

The execution time for preprocessing the palm print images was significantly reduced using the GMC-SE method because of the application of Edge based Tangent Model. By performing Edge based Tangent Model, common tangent of the two principal lines involving outside and topside of a palm is considered, resulting in minimizing the execution time by 18 – 54% compared to FRSD[1]. Besides, by applying midpoint of the two tangent principal lines, unwanted distortion is removed using GMC-SE reducing the execution time by 23 – 72% compared to PI-LRPP[2] respectively.

4.2 Measure of Computation Efficiency

Computation efficiency using GMC-SE is the ratio of images that are segmented to the number of images given as input. It is measured in terms of percentage (5). The mathematical formulation for computation efficiency is given as below;

$$CE = \frac{Images\ segmented}{No.\ of\ images} * 100 \tag{7}$$

Table 2. Tabulation for computation efficiency

No. of Images	Computation Efficiency (%)		
	GMC-SE	FRSD	PI-LRPP
20	70	60	55
40	72	63	59
60	75	66	62
80	79	68	65
100	70	61	59
120	73	64	62
140	75	67	65

Table 2 evaluates the computation efficiency required the different number of images and is measured in terms of percentage (%). Number of images used for experimental purposes varies from 20 to 140 and comparison is made with the two existing schemes namely, FRSD[1] and PI-LRPP[2].

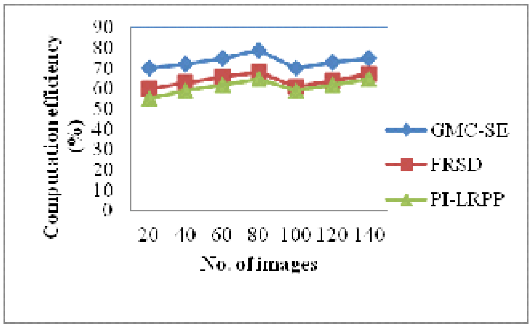

Figure 5. No. of images versus computation efficiency.

Figure 5 illustrates the computation efficiency with respect to different palm print images in the range of 20 to 140. From the figure it is illustrative that with the increase in the number of images, the computation efficiency is increased in all the methods. But, comparatively, the access patterns handled using GMC-SE is comparatively higher than the two other methods. This is because with the application of Gaussian Measure Feature Segmentation, both local and global palm print features are integrated by evaluating the spectral minutiae in the square regions. As a result, the GMC-SE method improves the computation efficiency by 10 – 14% compared to FRSD. In addition, with the aid of shift scaling and angular movement, each palm print is segmented into two regions by considering line segment as boundary lines resulting in the enhanced computation efficiency by 13 – 21 % compared to PI-LRPP respectively.

4.3 Measure of Feature Extraction Accuracy

Feature extraction accuracy measures the ratio of features being extraction to the number of images provided as input. It is measured in terms of percentage (%). Higher the feature extraction accuracy, more efficient the method is.

$$A = \frac{Features\ extracted}{No.\ of\ images} \times 100$$

Table 3. Tabulation for feature extraction accuracy

No. of Images	Feature Extraction Accuracy (%)		
	GMC-SE	FRSD	PI-LRPP
20	50	40	35
40	55	43	41
60	61	52	47
80	64	55	51
100	60	49	46
120	62	52	50
140	65	55	53

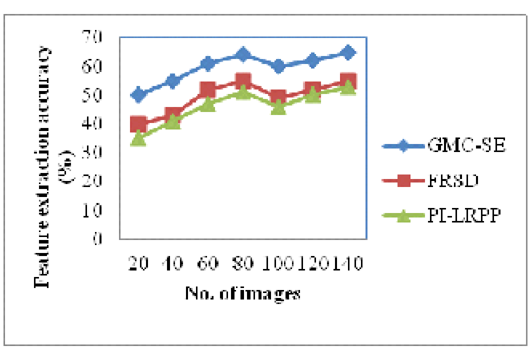

Figure 6. No of images versus feature extraction accuracy.

Table 3 and Figure 6 shows the feature extraction accuracy with respect to 140 images given as input. From the figure it is illustrative that the feature extraction accuracy using the proposed method GMC-SE is higher than compared to the two other existing methods. This is because of the application of Curvelet based Feature Extraction Model that significantly extracts the feature improving the accuracy rate of features being extracted. By applying Curvelet based Feature Extraction Model three minute lines are considered to extract the exact texture of palm print images improving the accuracy rate by 14 – 21% compared to FRSD. Furthermore, ridge candidate selection uses both local and global features based on scaling, angular movement and orientation improving the accuracy using GMC-SE by 18 – 30% compared to PI-LRPP respectively.

5. Conclusion

In this work, an effective Gaussian Measure Curvelet based Feature Segmentation and Extraction (GMC-SE) for palm print images is applied to improve accuracy and robustness of palm print features being extracted. To do this, we first designed an Edge based Tangent Model using edges of principal lines based on region of interest. Then, based on this region of interest, outside and topside of a palm among multiple time series were identified has a higher influential rate on execution time during preprocessing of palm print images. As a result, the execution time for preprocessing gets reduced. In addition, to improve the computation efficiency of features being segmented, competent Gaussian measure is obtained by integrating both local and global palm print features. Moreover, to improve the feature extraction accuracy, an effective Curvelet based Feature Extraction Model using scaling, angular movement and orientation is applied for different pattern sets. Extensive experiments were conducted to measure the efficiency of the proposed method GMC-SE using Poly U 2D Palmprint Database. We observed that our Gaussian Measure Curvelet based Feature Segmentation and Extraction for palm print images handled different images in an efficient manner compared to existing state-of-the-art works. In addition, our Gaussian Measure Curvelet based Feature Segmentation and Extraction algorithm effectively reduced the execution time, computation efficiency and feature extraction accuracy on several test sets.

6. References

1. Cao K, Liu E, Jain AK. Segmentation and enhancement of latent fingerprints: A coarse to fine ridge structure dictionary. IEEE Trans Pattern Anal Mach Intell. 2014 Jan; 36(9):1847–59.
2. Xu Y, Fei L, Zhang D. Combining left and right palmprint images for more accurate personal identification. IEEE Trans Image Process. 2015 Feb; 24(2):549–59.
3. Chen J, Moon Y-S, Wong M-F, Su G. Palmprint authentication using a symbolic representation of images. Image and Vision Computing. 2010 Mar; 28(3):343–51.
4. Valarmathy S, Karthiprakash R, Poonkuzhali C. Feature extraction technique based on circular strip for palmprint recognition. International Journal of Innovative Research in Computer and communication Engineering. 2014 Mar; 2(1):1–6.
5. Karar S, Parekh R. Palmprint recognition using phase symmetry. International Journal of Scientific and Research Publications. 2013 Apr; 3(4):1–6.
6. Liu E, Jain AK, Tian J. A coarse to fine minutiae-based latent palmprint matching. IEEE Trans Pattern Anal Mach Intell. 2013 Oct; 35(10):2307–22.
7. Park U, Park J, Jain AK. Robust keypoint detection using higher-order scale space derivatives: Application to image retrieval. IEEE Signal Process Lett. 2014; 21(8):962–5.
8. Shameem Sulthana ES, Kanmani S. Implementation and evaluation of SIFT descriptors based finger-knuckle-print authentication system. Indian Journal of Science and Technology. 2014 Mar; 7(3):374–82.
9. Anitha U, Malarkkan S. A novel approach for despeckling of sonar image. Indian Journal of Science and Technology. 2015 May; 8(S9):252–9.