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Analysis of shape and texture based palm print recognition system for biometric identification

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ABSTRACT

Biometric systems are widely used in access control and security-based applications. The goal of the biometric system is to utilize physical and/or behavior characteristics to identify/verify the subject of interest. There are so many biometric systems that are based on physical and/or behavioral properties such as the face, iris, speech, keystroke, palm print, retina, etc. Among these, the palm print-based biometric system that has been investigated for over 15 years has demonstrated its applicability as a successful biometric modality. It shows a unique feature that can be obtained using texture features which are present due to the presence of palm creases, wrinkles, and ridges. Furthermore, the palm prints can be captured using low-cost sensors with very low-resolution imaging. In this paper we propose a novel scheme for palm print recognition using shape and Texture-based feature (like Average gray level, Average contrast, Measure of smoothness Measure of uniformity, Entropy, Static Moment & Centroid) analysis obtained from Statistical Image Features. The palm print image is characterized by a rich set of features including principal lines, ridges, and wrinkles. Thus, the use of an appropriate texture descriptor scheme is expected to capture this information accurately.

Keywords— *Image processing, Biometric, Texture, Recognition, Palmprint, Fingerprint, Authentication, Collectability, Extraction*

1. INTRODUCTION

Authentication is the process the validating the user who is attempting to gain access to a system. Traditional authentication and authorization system were based on password and keys. These passwords were hard to remember and could be easily stolen and the unauthorized person can easily gain access to the system [1]. Usage of biometrics gets rid of all these insecurities. A biometric form of authentication is safer because biometrics of an individual cannot be stolen and there is no need to remember any passwords.

Biometric authentication relies on the unique biological characteristics of individuals to verify the identity for securing access to a system. Generally, individuals are identified based on physiological and behavioural characteristics. The behavioural characteristics include the signature, voice, keystroke dynamics and giant. The physiological characteristics are finger and palm prints, iris and retina scans, hand, face and ear geometries, vein and nail bed etc. [1] [2] [4]. Automated methods of verifying or recognizing the authenticity of a person are based on such characteristics of individuals. Among these, the most popular characteristics are the finger, palm prints and iris scans. Biometric systems are increasingly found in many places such as airports, banks, and hospitals etc., human traffic and to maintain a secure environment.

The Palm print recognition is one of the most necessary applications of the biometrics-based authentication systems. Traditionally, ID card or Passwords have been used for applications, ranging from airport security, attendance marking, prevent from access to restricted areas, online banking. These types of identity recognition methods exhibit serious disadvantages, as security issues are still at stake [1]. In biometrics, person identification is uniquely done on the basis of the person's behavioural/physical attributes. For access control applications, biometric-based technologies can be used. Biometric methods are becoming the backbone of highly secure personal identification and verification alternatives. As the security breaches and transaction frauds are increasing, the need for new technologies that provide high security is very much essential. The major advantage of biometric methods over existing methods is unique for each person and cannot be time-varying. The palm print recognition system works by taking the person's palm as a biometric tool for authenticating and identifying a person's identity. Palm print patterns are a very reliable and accurate biometric that require minimum cooperation from the user for extraction. The devices with low resolution can easily capture the palm print which also contains additional features namely ridges, flexion creases and secondary creases of the palm print. Therefore the palm print recognition system can be very much useful for everyone and it does not require any personal information of the user and less expensive also.

Palm consists of principal lines, ridges and wrinkles. These three attributes are dependent genetically; most of the other attributes are not. The palm prints are different even for identical twins. These palm print patterns are very much useful for authentication of the person. Most of the system uses the low-resolution image of the palm which is the inner surface of the hand between the fingers and wrist. The features of the palm print are extracted in the feature extraction stage after preprocessing the palm print images. Later, the features of the captured image are compared with the stored database. The methods for low-resolution palm print images (75 or 150dpi) are very much evident. The methods for extracting the features of the low-resolution palm print image include different edge detection techniques. The principal component analysis or linear discriminant analysis is used to reduce their dimensionality. To compare the reduced features, distance measures or classifiers are used. The features namely singular points and minutiae are also extracted for palm print images which have high resolution (500dpi).

Fig. 1: Online Palmprint Image

Fig. 2: Offline Palm print Image

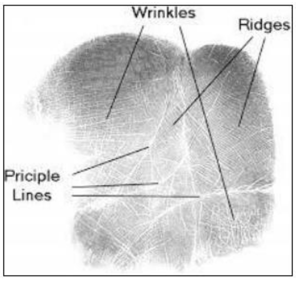

Fig. 3: Features of Palm print Image

2. PROPOSED METHODOLOGY

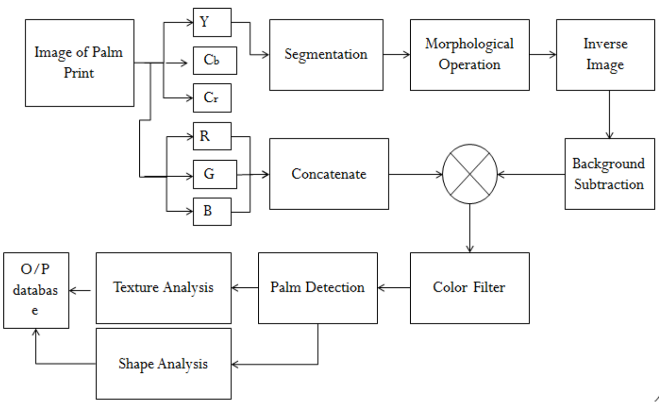

Fig. 4: Flowchart of Proposed Methodology

The procedure of Proposed Methodology:

(1) Palm print is obtained using image acquisition technique then Pre-processing of Palm print is done.
(2) First of all, Image is converted into its complementary image of Y, Cb, Cr channel.
(3) The red colour is dominating channel due to its illuminance hence red channel of the image is chosen for the processing.
(4) Image segmentation is performed in order to extract the separate pattern. After that morphological operation is carried out to get features of the image.
(5) The background image is obtained by applying the inverse to the image. Hence palm print is gathered.
(6) Texture analysis and shape analysis is performed to get the features of the image like Average gray level, Average contrast, Measure of smoothness Measure of uniformity, Entropy, Static Moment & Centroid.
(7) KNN classifier and Euclidean distance are used to classify the image and to evaluate the accuracy.

3. DESIGN AND IMPLEMENTATION

There are 5 basic steps that are implemented in designing of Palm print recognition system.

1. Image capturing
2. Shape analysis
3. Texture analysis
4. Feature extraction
5. Matching

3.1 Image capturing

In this first step, we collect image samples from different users. Then for each sample image, we obtain the central portion of palm because this portion of palm (i.e. palm region) is discriminatory for a different person. Thus this pre-processing is required before feature extraction and coding step. Preprocessing operations are filtration operation on images of palm. Here we commonly remove background noise having low-frequency, normalize image intensity for every pixel, remove any existing reflection, and mask some portions of images. Therefore during pre-processing of the image we enhance data images before to computational processing.

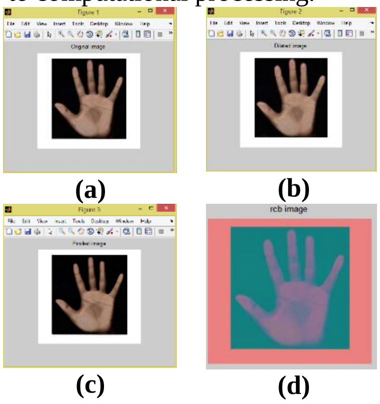

Fig. 5: (a) Original Image (b) Dilated Image (c) Eroded Image (d) RCB Image

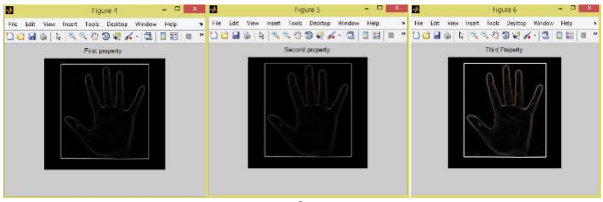

Fig. 6: (a) 1st Property (b) 2nd Property (c) Third Property

3.2 Shape Analysis

For shape analysis, different edge detection technique is applied and it is seen that Sobel edge detection technique is providing the better result. Then segmentation is carried out and centroid feature is extracted for every image which is saved in the database as a feature matrix.

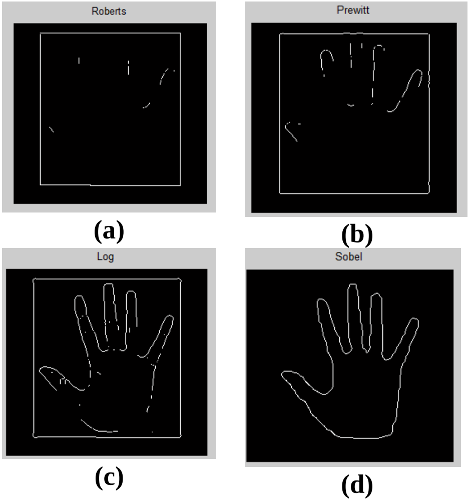

Fig. 7: Different Edge detection Technique (a) Roberts (b) Prewitt (c) Log (d) Sobel

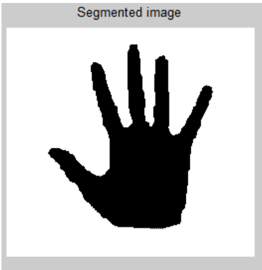

Fig. 8: Segmented Image

3.3 Texture Analysis

For the Texture Image First of all ROI is extracted from the image. ROI of palm print can be represented in a 2D array of M*N. It is defined as a vector in the Eigenspace method. Now, all palm vector of the training set used to represent the principal components of the Eigenvectors of the covariance matrix. Those Eigenvectors define the subspace of the palm print, which are called "Eigen's palms".

Method for extraction of ROI has the following important steps:

1. Separate the fingers from the palm.
2. Identify two valley points first between the ring and little finger and second between middle and index finger.
3. According to two valley points rotate the image and the finally correct position of the image.
4. Finally, determine ROI (Region of Interest).

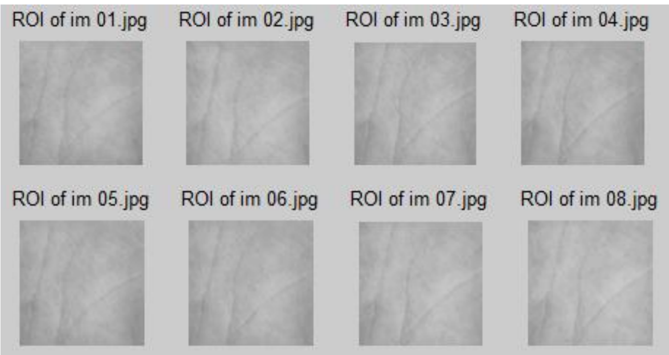

Fig. 9: ROI of different sample Image

3.4 Feature extraction

After dataset pre-processing various features are extracted from processed palm image. Following are the extraction of a feature from palm print.

1. Average gray level
2. Average contrast
3. A measure of smoothness Measure of uniformity,
4. Entropy
5. Static Moment &
6. Centroid

3.5 Feature Matching

For available two data sets, we use an algorithm to match and find the percentage of similarity between them. A feature of the test image and training images are extracted using the above method. To perform the best matching of the test image, the measuring is done on the basis of the distance to locate the similar points of two palm prints. The nearest neighbour differentiator gives the ideas to determine the distance of the input image with the image that is already present in the database. ROI is always the same for same user palm.

Thus ROI is also one of the most important features of palm print image identification and all of the other features are present in this palm region. To extract ROI according to the location and segmentation, it reduces the difficulty in image matching and improves the robustness of the matching algorithm. The processing on extracted feature vectors is done by K- Nearest Neighbor (KNN) classifier. The KNN classifier is used to compute the minimum difference in feature vectors of a user with an existing database sample.

4. RESULT AND DISCUSSION

On the basis of the proposed methodology, the palmprint is implemented for the biometric application process. The outline of the process can be seen from the below-described pedagogy:

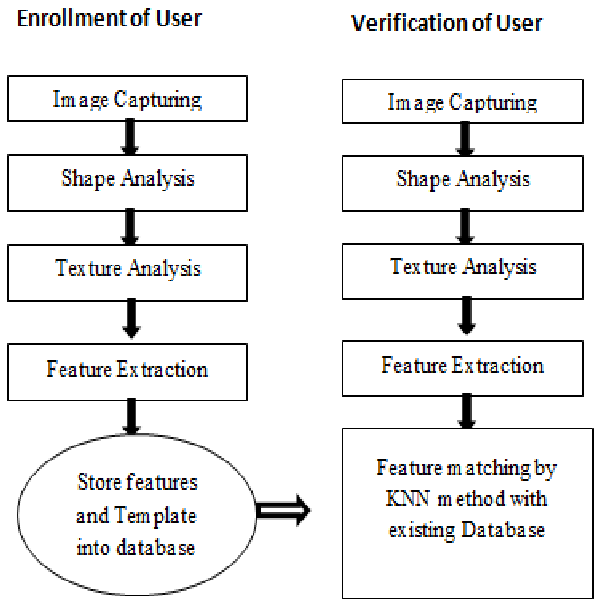

Fig. 10: Outline of the implemented work

Extracted feature for different samples has been tabulated below and these features are matched with the palmprint using KNN Method.

Table 1: Texture analysis features

Image database	1st C.M.	2nd C.M.	3rd C.M.	4th C.M.	5th C.M.
1	0.9034	0.0265	-0.0085	0.0047	-0.0025
2	0.9164	0.0151	-0.0023	0.0007	-0.0002
3	0.7559	0.0661	-0.0050	0.0059	-0.0012
4	0.2049	0.1081	0.0378	0.0261	0.0140
5	0.1974	0.0737	0.0203	0.0117	0.0051
6	0.2135	0.0804	0.0226	0.0144	0.0068
7	0.2552	0.1138	0.0329	0.0259	0.0132
8	0.9115	0.0224	-0.0059	0.0026	-0.0011

Table 2: Feature extraction (Central moment) from the database

Data base	Average gray level (T_1)	Average contrast (T_2)	Measure of smoothness (T_3)
1	230.3736	83.0547	0.0775
2	233.6860	62.7343	0.0447
3	192.7560	131.1529	0.1861
4	52.2587	167.6926	0.2927
5	50.3475	138.4800	0.2060
6	54.4466	144.6504	0.2234
7	65.0801	172.0703	0.3066
8	232.4240	76.3322	0.0657

Data base	Third moment (T_4)	Measure of uniformity (T_5)	Entropy (T_6)
1	-8.7071	1.5667	24.3503
2	-2.3304	1.1600	25.3156
3	-5.0617	0.4967	31.9104
4	38.5799	2.1027	19.7907
5	20.7369	0.6214	28.5209
6	23.0128	0.3263	33.5687
7	33.5252	0.7961	31.8139
8	-5.9925	0.9174	26.3702

Table 3: Centroid of the Image from the database

Image data base	X- coordinate Location	Y –coordinate Location
1	105.6345	117.9048
2	97.2337	129.1437
3	114.9445	108.6358
4	115.5634	130.2694
5	46.0867	48.3846
6	37.9235	56.4943
7	48.4265	47.7662
8	58.5056	40.0257

The proposed work has been implemented using Matlab Simulator, version 2012. The database for the palm print has been taken from the IIT Delhi Touch less Palm print Database (Version 1.0). This database employs user-pegs to restrict the hand-pose and image scale variations. It helps in restricting the palm print texture image variations. This is one of the key reasons that researchers achieve significantly higher performance [1].

When the accuracy is calculated for the test image and training image it is found that the accuracy rate is 99.37%.

$$Accuracy = \frac{No.of\ correct\ Image}{Total\ Image} \times 100$$

Total Number of Image: 160 (20 samples per image)
No. of Correct Images: 159 (Samples per image)

$$Accuracy = \frac{159}{160} \times 100 = 99.37\ \%$$

Table 4: Comparison with the literature survey

Ref.	Method	Feature	Classifier	Accuracy
[14]	Wavelet Transform	Region extraction using wavelet coefficient	Neural Network	75.6%
[15]	2-D Gabor Filter	Texture analysis for low-resolution palm print images	Euclidean Distance	91%
[16]	Extraction of palm print ROI	ROI of hand, heart line extraction	Local Binary Descriptor & Euclidean Distance	94%
[17]	Spoofing method & Extension of Weber's algorithm	Liveness detection algorithm,	Euclidean Distance	99%
[18]	Scattering Wavelet Transform	scattering coefficient obtained through wavelet filters	SWT features, Euclidean Distance	91%
[19]	Fuzzy Entropy	Entropy Information Features	Shannon entropy, SVM Classifier	92.3%
[20]	PCA	Global and Local Features	Gabor filter	98.12
[21]	Texture-based features	sparse representation of features (B-BSIF)	sparse representation classifier	More than 90 % for different database
Proposed Method	Colour, Shape and Texture-based analysis	Average gray level, Average contrast, Measure of smoothness Measure of uniformity, Entropy, Static Moment & Centroid	KNN classifier, Euclidean distance	99.37%

5. CONCLUSION

In the current scenario where we are living in the information age, because of the advent of technology, there is a situation like an information explosion. Images have a giant share in this information. To access the large image archives more précised retrieval techniques are needed for finding relatively similar images.

In this research paper, we proposed a modified approach using colour, shape and texture based feature extraction. In our proposed approach, we provide better accuracy with less complexity in recognition of palm print. In this proposed technique first, we pre-process the palm print database because the central part of palm (palm region) is discriminatory for a different person. Then we extract ROI (Region of Interest) and remove other portion of palm area and pre-process it for further feature extraction. Various features based on shape, colour and texture are extracted from the pre-processed image and best matching is performed on existing database template. The implemented result shows an accuracy rate of 99.37%, which is better than the previous work carried out by the researcher.

This research is done on the small database but in future, this can be implemented on the large database to check its accuracy and its complexity for real large implementation.

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