RECENT ADVANCEMENTS IN PALMPRINT BIOMETRIC – A SURVEY

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Abstract
Biometric based authentication is the current day evolving technology, wherein, the accuracy of the system must be maintained in such a way that there is no reduction in recognition accuracy with the increase in the number of classes. One such biometric trait which provides better recognition is palmprint. The palmprint of a person may not vary until unless any ailment alters its structure and pattern. It is considered as one of the best noninvasive biometric trait out of all the existing traits. The paper outlines the existing techniques that are developed for authentication using palmprint. Most of the techniques rely on texture, phase and frequency based feature extraction. Accuracy achieved is limited to 99% with the use of existing classifiers and classification techniques.
Index Terms: Biometric, authentication, texture, phase, frequency, palmprint, recognition accuracy, classifier.

I. INTRODUCTION

Advancement of Technology as made users to use biometrics for security purpose in contrast to the user's password based or Text based system which is used for authentication for the past decade. Palmprint is one such biometric which is used widely in the recent past and is under investigation by several researchers. Palmprint images may be basically classified as high resolution and Low resolution images wherein the former are used in forensic applications and the later used for normal applications such as authentication and access control. Such a system which considers such biometrics for processing must be cost effective, ease in use, must be capable of environmental hazards, and better accuracy with good false rejection rate. The algorithms that are designed for such a biometric system must be in such a way that they have less computational complexity, considering these algorithms to be deployed in a standalone system having minimal configuration [1].

Existing biometric modalities viz., Iris, Fingerprint, Face are widely used for authentication purpose but these modalities suffer from various limitations which place them in the last place of usage for consideration in any biometric system. Fingerprint suffers from hygiene problem during authentication and training. Further marks of finger on the scanner remain, causing a serious degradation in the scanners performance [2]. Iris recognition is observed to have better accuracy when compared to the existing biometrics but still the camera or scanner requirement is the main problem for a such a biometric which uses near infrared camera for acquiring the images[3].

Features that are extracted from a palmprint are primarily based on principal line extraction which uses different types transformations for better extraction of these lines and texture. These approaches are basically divided into three categories such as holistic, structural and hybrid. The holistic approach uses global features along with statistical features but such features tend to be very sensitive to illumination, distortion and variation in rotation and translation. Structural approaches uses combination of principal lines,

coding schemes and texture features[6,13] that are extracted from the palmprint. The disadvantage of such approaches is its computational complexity, unstable results in the process of principal line extraction. Coding schemes may be of less complexity with high accuracy but are in less use. Hybrid approach uses combination of the holistic and structural approach which require more time for computation [4].

The existing palmprint recognition techniques use contact based acquisition of images. Palmprint images that are acquired using scanners that require contact of the palmprint image restrict hand-pose and image scale variation because of fixed marking on the scanner. New era devices expect the images to be acquired on the fly. Hence, contactless palmprint recognition came into picture which have several limitations in terms of capturing of image to attaining accuracy [5]. Palmprint recognition is a non-invasive technique which has received much attention because of its non-intrusiveness and providing the capability of ease in collecting the data from the users. Contactless palmprint are of much importance for the users who suffer from skin ailments and elderly people who suffer from arthritis [8]. Palm prints that are acquired using contactless devices face problems in pose, rotation, illumination, translation and projection, which results in blurring of the image. Further, infraclass variations are observed due to the absence of any contact on the surface of the scanner which may be unable to handle the variations in palmprint absence. The elements which represent texture in elements degrades the performance of the system, when the camera and palm are in relative motion which makes palm print recognition a difficult task. Further, grayscale based palmprint recognition system can easily be morphed by making fake imprints[14].

All the existing palmprint recognition techniques are based on 2D images whereas new techniques are evolving which are based on 3D palmprint recognition which is expected to have high performance owing to its high cost capturing device [7]. Multi spectral palmprint images which are collected from different spectral banks that are formed from different light wavelengths are also considered as the skin having peculiar property of observing and reflecting some wavelengths of light resulting in extraction of different features for different wavelengths that are being reflected [9-10,12].

The major problem that exists with the existing scanners is blur effect which severely effects the performance of the system unfortunately this is the area where researchers in the past have put less concentration and has not attracted much attention in the current research problem of palmprint recognition. There are various problems to be addressed in palm print images that have been become blur in the process of acquisition and preprocessing. Initially we need to indentify the reasons for the blur in the image at different scales, further variance operations like translation and rotation need to be performed for effective recognition based on the efficient features that are extracted from the palmprint [11].

Figure 1 shows a palmprint image which clearly shows the principal lines[38]. The principal lines are marked in the image which are extracted from the preprocessing phase. Analysis on these principal lines is very imperative in further phases of palmprint recognition system.

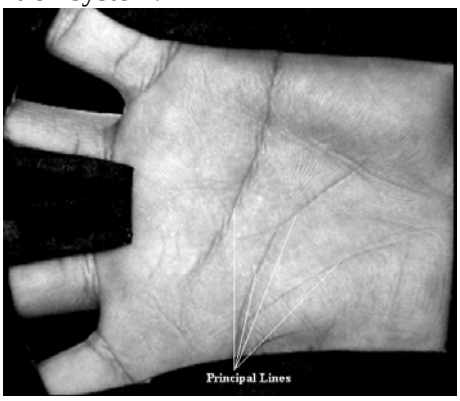


Figure 1. Palmprint image [39]

Figure 2 shows the zoomed version of the image wherein the image is cropped and zoomed for extraction of various features from ROI (Region of Interest) based on the imprints that exists on the palmprint image that is acquired. These imprints may be classified as minutiae in terms of fingerprint, whirlpools and some special

marks that can be considered for processing. These marks can be taken as independent features of each class and these may also vary from instance to instance depending upon the pressure and posture of the hand while acquisition.

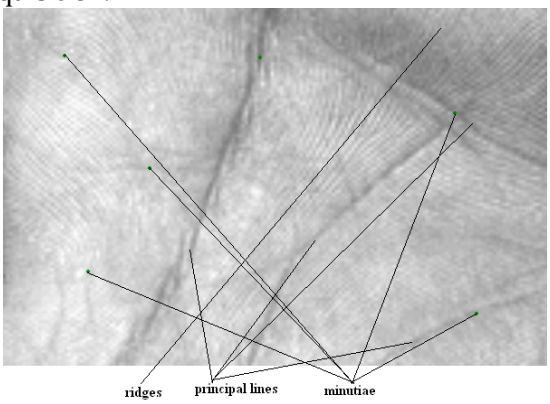


Figure 2. Result of the cropping and zooming ROI for further processing.

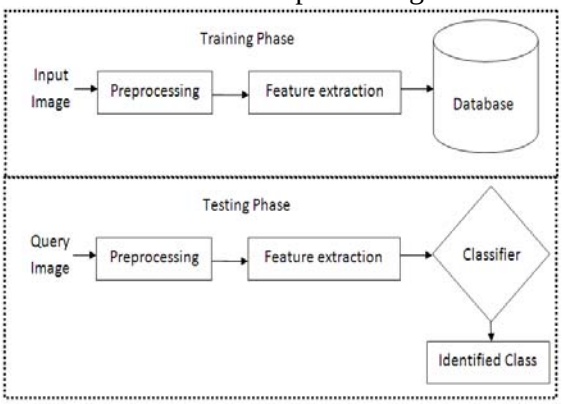


Figure 3. Basic Process of a biometric based authentication system.

Figure 3 shows the basic block diagram of a biometric based authentication system which includes training and testing phases. In the training phase, the images that are acquired are stored in the database are read and are preprocessed. Then, from each image different features are being extracted which are stored against each biometric which is identified by the corresponding class number. All the features that are extracted are stored in the database for further testing purpose. In the testing phase, the same process that is carried out is training phase is carried out and classified using a predefined classifier. The result out of the testing phase is the corresponding class that is identified by the classifier.

II. IMAGE ACQUISITION AND PREPROCESSING

Image acquisition is the first step in any biometric based recognition system. Most of the literature is based on deciding what type of camera to be utilized for acquisition. Collective approaches such as the use of digital cameras in contrast to the use of CCD or acquisition are also one the flow. It is observed that the drawback of the CCD based acquisition is that there is blur that is observed in some parts of the palm which is shown in figure below.

Preprocessing is the next step for aligning the palmprint images, further, segmenting the images for feature extraction. Most of the existing algorithms concentrate on extraction of the feature points which are based on global scale. Common steps that are involved are: conversion of the acquired image to binary, segmenting the palm for extraction of ROI, detection/ identification of the key points, identifying the coordinate system for further processing, extracting the ROI[1].

III. FEATURE EXTRACTION

The first and foremost part of the feature extraction is the extraction of ROI from the palmprint image which eliminates the clutter in the palmprint and extracts only the required parts of the image. For processing of this ROI extraction a coordinate system need to be developed such that the ROI can be cropped from the actual image and used for further processing[7]. Different features are extracted from the extracted ROI image. Use of Log Gabor Filter Bank extracts the features of the image in different scales and orientations which are the encoded coefficients.

D.Hong et. Al[11] proposed Block Dominant Orientation Code (BODC) technique for the extraction of the features which are used for rough recognition initially and the result that is obtained is fine tuned to improve the recognition accuracy using Block based Histogram of Oriented Gradient (BHOG).

Texture is one of the prominent feature that exists in the palmprints. It is observed that these features vary with orientation of the lines in the palmprint and ridge frequency which are

difficult for extraction in the presence of noise[14].

The features that are extracted from ROI must be capable enough of representing in such a way that they can be easy classified by the use of a linear classifier which reduces the overhead in the processing when compared to the use of a non-linear classifier. The features extracted must be in large number which also improves the accuracy of the classifier. As the number of features increase, the overhead in the processing or computational complexity interms of training and classification also increases. Hence, optimal feature selection is required for the extraction of the prominent features from the ROI. Kernel based feature processing is one technique which projects the features into a n-dimensional space where n number of features can be easily classified using a linear classifier. [15, 40]

Local Binary Pattern is another technique which extracts the texture features from the palmprint image and also differentiated the grayscale texture that identifies the spatial structure of the local image texture[19].

Wang Xinchun et al.[22] proposed the use the curvelet transform by providing a modification over the existing first generation transform. It is a well known fact that the prominent feature of a palmprint image is the curves that exists on the image. These are used as features for further processing. Different features that are extracted using different techniques that results in various parameters viz., points, lines from the palmprint images. There are other techniques such as subspace, coding, statistics based techniques[41] which also extracts various parameters from the image. Out of these, the recognition speed of coding based and fusion of multiple features based techniques is high when compared to the other techniques. All these techniques compare the test image features with that of the trained image features using only the derived features in contrast to the template based matching. In a template matching technique, the size of the template increase with the increase in the number of features that are extracted, in particular, point, fusion of multiple features based technique will result in a large size of the template. Such a large dimension template also results in increase in the computational complexity which is more in these cases[23]. Further, different approaches were present in the literature which try to reduce the dimensionality of the feature vector thus increased, fusion of different features to identify the prominent features which help in classification[26]. Kernel is an operator which projects the feature space into a n-dimensional feature space where the features can be easily separated using a linear classifier[40]. This can also be attributed to dimensionality reduction which is capable by the use of KPCA which is given by

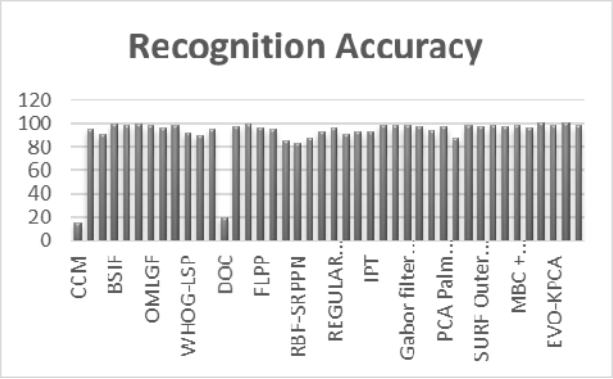
$$(Kf)(x) = \int_{y_1}^{y_2} k(x,y) f(y) p(y) dy \text{ [30]}$$

Where the output is given by $(Kf)(x)$, $f(y)$ is the input and $kx,(y)$ is the kernel function that is to be chosen based on the user. There are three kernel functions used widely, RBF, Sigmoid and Linear kernel functions[40].

Histogram of oriented gradients (HOG) is another descriptor which is used widely in the recent past for image recognition and detection. However, in particular, for palmprint recognition, this technique cannot give better result as the image will be having different widths and complex lines on the palm. But, one can also suggest to preprocess the image to have scaling mechanism to have a unified size for all the images. Then, this technique cannot be used in the real time where we acquire the image on the fly. Hence, Wei Jia et al. proposed Histogram Oriented Lines (HOL) descriptor which is another variant of the HOG used for extraction of the lines from the palmprint image[31]. C.Phromsuthirak et al. [33] proposed to find key points. These points are identified on the tips and valleys of the fingers that are considered as the reference. Further, affine transformation[36] is applied to extract the features from the image. The accuracy of the technique entirely depends on the quality of the acquired image and the computational complexity is more. Another class of filter that are used for feature extraction are steerable filters[34] that can be rotated efficiently by combining small basis filters into a large filter. In contrast, to the filter bank based approach, steerable filter provides better results.

IV. CLASSIFIERS USED IN PALMPRINT RECOGNITION

The selection of a proper classifier provides better recognition rate. In the current scenario, the database size increases as the system that is developed by any production based company will be designed for a large size population to be authenticated. As the database size increases, the error in recognition also increases. Hence, there is a necessity to improve the recognition rate along with the increase in the number of classes in the database. Primarily, classifiers are divided into two categories as linear and non-linear. As the number of classes increase the interclass distance decreases which tend to have the use of a non-linear classifier in contrast to the use of a linear classifier which is computationally less complex. Lunke Fei et al.[17] proposed Double orientation non-linear matching using the features that are extracted from double orientation extraction algorithm. This algorithm extracts the Gabor features using a filter bank and convolves all the pixels of the image with that of the filter bank. The output of the convolution is the orientations and two most dominant outputs are considered as the final features which are given as an input to the classifier. To evaluate the similarity of double orientation code that is developed, the difference in orientation is computed, if found less, have a better matching. Zhenhua Guo et al[18] used Euclidean distance to measure the dissimilarity. It is observed that Euclidean distance based classification results in misclassification. The accuracy in classification can only be improved by the use of proper feature selection only. Jiajun Wen et al[20] has developed a multi step method which calculates the effort of a class in comparison to that of the test sample presented. The class that provides a minimum effort will be discarded and the remaining classes will be considered for further classification. Such an approach has resulted in a reduced error rate of 2.63% and 2.07% which are obtained by varying the parameters. The interclass distance must be properly selected for a better classification. Fisher Locality Preserving Projects (FLPP)[21] maintains such a better distribution of the class separation their neighborhood structure. The classifier must be properly selected in such a way that it must be able to classify even when the noise is introduced in the test pattern. Such a technique is generally used by hackers. With use of FLPP an accuracy of 99.8% is achieved. Generally, kernel based classifiers are used for non linear classification[40]. The proper selection of the selection results in better classification. An extension of KPCA is presented as Evo-KPCA[30] which is presented as a technique that results in speeding up the process of the system. Such a system is observed to have an accuracy of 98%.



V. CONCLUSION

Reliable authentication in a complex environment is the order of the day. The traditional technologies are being replaced with biometric based authentication systems which must authenticate the uses on the fly. Current systems that are being deployed are touch based systems which have a limited accuracy of 99%. The time in recognition is also high. As the number of classes increase, it is observed that the FAR may also increase. The existing systems are tested only with limited number of classes. Further, rotation in the biometric is not considered perfectly. If the image is rotated, then the system may have an increase in the ERR. There is a need for the system to be developed which can concentrate on acquiring, processing and further authentication users on a touch less based system. As these systems mainly concentrates on noninvasive based biometrics touchless based systems can be utilized more in number to have authentication on fly. The features that are extracted from a palmprint are also limited in number which have less interclass distance, forcing the classifier to have an increase in the ERR resulting in more FAR.

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