Survey on Multimodal Biometric using Palm print and Fingerprint

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ABSTRACT
The survey on palmprint and fingerprint has been investigated over many years. Fingerprint is a popular biometric identification technology and studies are still going on in the palmprint identification. But researches based on the multimodal biometric that combines palmprint and fingerprint technology, which will provide better security and robustness comparing to the stand alone model have not been that much expanded. This paper provide an overview of current palmprint and fingerprint technologies describing in particular the different pre-processing techniques, feature extraction, fusion techniques and varieties of matching algorithms. Finally some suggestions are also provided based on the theoretical study.

Keywords
Biometrics, Palmprint, Fingerprint.

1. INTRODUCTION
The sudden growth in the use of Internet applications and the great concern of security require a reliable personal identification system. Traditional automatic personal identification schemes can be divided into two categories: knowledge-based, such as a password and token-based, such as a physical key, an ID card and a passport. However, these approaches have many limitations. In the knowledge-based biometric approach, the "knowledge" can be guessed, forgotten or can be shared. In the token-based biometric approach, the "token" can be easily stolen or lost. These things strongly indicate that we need a more effective and reliable solution for human identity management. Biometrics is regarded as the potential solution. Biometric authentication refers to the technology for personal identification or authentication based on our physiological and/or behavioral characteristics.

Biometrics can be divided into two types. Unimodal and multimodal. Many unimodal biometrics system suffer from limitations such as inability to tolerate deformed data due to noise, deformed data from the sensor device, distorted signal from environmental noise and variability of an individual's physical appearance and pattern over time. Multimodal biometrics are able to solve some of these limitations by combining information from multiple biometric sources. eg palmprint and fingerprint, face and iris etc. But storage requirements, processing time and computational demands of a multimodal biometric system can be higher than that of unimodel system.

The design of a biometric system consists of five objectives : cost, user acceptance and environment constraints, accuracy, computation speed and security[34]. Reducing accuracy can increase speed. Reducing user acceptance can improve accuracy. Increasing cost can enhance security. A practical biometric system should balance all the five objectives.

Among the many current biometric technologies, fingerprint identification is the oldest and the most popular one. Fingerprint technology has low cost comparing to others and high user acceptance. It is the method of identification using the impressions made by the minute ridge formats or patterns found on the fingertips. For every individual the ridge patterns will be different throughout the life. Fingerprints will offer an infallible means of personal authentication. Other personal characteristics may change, but fingerprints do not. However some people do not have clear fingerprints because of their physical work or problematic skin. Iris and retina recognition system provide very high accuracy [30] but input devices cost high. Many researchers have focussed on face and voice [29] but their performance is very low.

Comparing to the many biometric traits existing palm prints have many advantages. The inner surface of the palm normally contains principle lines, wrinkles and ridges. The principle lines and wrinkles are formed between the third and fifth months of pregnancy and superficial lines appear after we born. Even identical twins have different palm prints. Combining both fingerprint and palmprint for personal identification will give a better security and accuracy. The following sections provide a survey on different technologies used on fingerprint and palmprint and give some suggestions regarding the best method.

A typical multimodal biometric authentication system consists of five parts. Image capture, pre-processing, feature extraction, fusion and matching. Special biometric scanners are used for image capturing. It may vary depending on the type of biometric traits used [1,2]. At the pre-processing stage the image is enhanced to remove noise and unwanted areas. Different pre-processing methods are explained in the coming sections. Feature extraction gets effective features from the pre-processed biometric trait. Feature extraction for palmprint and fingerprint are different. After feature extraction fusion is carried out to combine different features and stored in the database as templates. A matching algorithm is used to compare it with the stored one in the database. Fig 1 gives the basic block diagram of a biometric system. Attention should have to be paid in the security of biometric trait also.

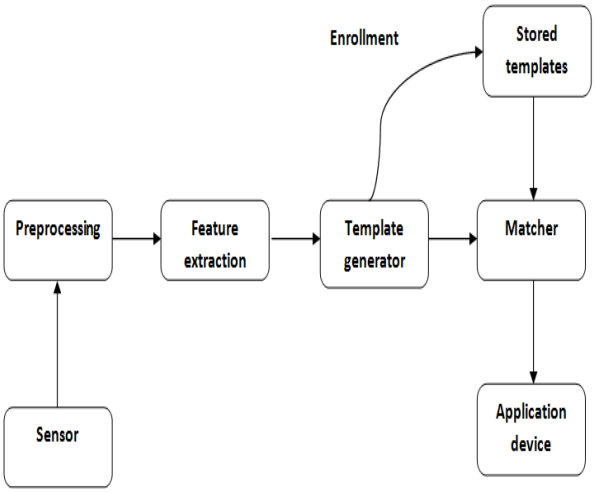

Fig 1 : A typical Biometric System

2. PRE-PROCESSING

Pre-processing is carried out for palm print and fingerprint separately. After the image is captured by the scanner it may be distorted or blurred due to the bad environmental conditions. In these conditions a good pre-processing method is a must. The goal of fingerprint image pre-processing is to increase the clarity of the ridge structure so that minutiae points can be easily extracted. Low pass filters like Gaussian can be used for smoothening. In [32] in addition to Gaussian filter, Short Time Fourier Transform (STFT) analysis is adopted to enhance fingerprint image quality. Sometimes the binarized fingerprint image contains a number of false minutiae. In [27] a detailed pre-processing is mentioned to remove false minutiae.

Palm print images pre-processing is mainly carried out to extract the region of interest. Palmprint pre-processing involves four common steps. 1)Normalizing the images 2)Filtering to remove noise 3)Binarization 4)Extracting the central part for palmprint image. The first two steps in all the pre-processing algorithm are similar[3,4]. The images captured in different scanners will have different size. So normalization is used to make everything in a common size. Low pass filter is used for noise reduction. They are also called as smoothing filters. A low pass filter will let low frequency components to pass and reduce high frequency components. Binarization is also a part in pre-processing. Binarization is applied with the help of a threshold value. It will convert the original image into a binary image. A detailed description of binarization is given in [5].

For palmprint images, the central part, called the Region of Interest should have to be extracted. For extracting the central part, a coordination system should have to be established. There are several implementations including tangent [1], bisector [6,7] and finger based [8,9] to detect the key points between fingers. Among these, tangent-based approach will take two boundaries, one from middle finger and point finger and the other from ring finger and last finger as two convex curves [1]. The two intersections are considered as two key points for establishing the coordinate system. Tangent-based approaches is having several advantages. They will depend on a very short boundary around the bottom of fingers. So, it is robust to incomplete fingers (as in the disabled) and the presence of rings. Bisector-based approach will make a line using two points, finger boundary center of gravity and the midpoint of its start and end points [6,7]. Intersection of the line and the finger boundary is considered as a key point. There are two types of finger based approach. Paper [9] uses middle finger and [8] uses point, middle and ring fingers to establish the coordinate system.

After computing the coordinate systems, the central parts of palmprints, which is called the Region of Interest (ROI) are segmented. In most of the pre-processing algorithms, ROI will have square shape but some of them will have circular [10] and half elliptical shapes [11]. Among these,. Circular and half elliptical regions may be easier for handling rotation variation and square region is easier for handling translation variation.

3. FEATURE EXTRACTION

3.1 Fingerprint Feature extraction

For extracting the features from the fingerprint image, a popular method is minutiae extraction. A fingerprint is made of a series of ridges and furrows on the surface of the finger. Minutiae extraction algorithm will find out the minute points from the fingerprint and then map their relative placement on the finger. When the fingerprint is of low quality, it will be difficult to extract the minutiae points. For that only we are using different filters and other image enhancement techniques at the pre-processing stage. The output of this algorithm will be the image template containing the minutiae details. There are two types of minutiae points. Ridge ending and Ridge bifurcation[4]. In [26] an advanced fingerprint feature extraction method is introduced through which minutiae are extracted directly from original gray-level fingerprint images without binarization and thinning. Gabor filter bank can also be used to extract features from fingerprint [24].

3.2 Palmprint feature extraction

Comparing to fingerprint, palmprint contains more features. So a good method should be applied in order to extract all the features. The feature extraction methods can be divided into three types. Line based approach, Subspace based approach and Statistical approach.

In line based approaches, they use existing edge detection methods to extract palm lines[12]. Subspace-based approaches also called appearance-based approach. They use principal component analysis (PCA) [20,16], linear discriminant analysis (LDA) [25] and independent component analysis (ICA) [28]. Paper [21] proposes matrix-based complex PCA (MCPCA), that uses a complex matrix to denote two biometric traits from one subject.

Statistical approaches are two types. Local and global statistical approach. Local statistical approaches transform images into another domain and then divide the transformed images into several small regions[13,14]. Gabor, wavelets and Fourier transforms have been applied. Global statistical approaches [15] compute global statistical features directly from the whole transformed images. Moments, center of gravity and density have been regarded as the global statistical features. An advanced technique called Local Binary Pattern can also be used [35] to for palmprint feature extraction.

At the earlier stages researchers used only filters to extract features from palm. In [5] palmprint is considered as a piece of texture and 2-D Gabor filter is used to extract the features. This is called texture based feature extraction. The main

disadvantage of this method is that filters cannot extract all the features.

4. FUSION

Fusion is a good way to increase the system accuracy and robustness. Features taken from different biometric traits should have to be fused together. Many biometric traits including fingerprint and palmprint[17],fingerprint, palmprint and face[18], fingerprint, iris and face[19] have been used. But fusion of palmprint and fingerprint will give better result comparing to others. There are four levels of information fusion. Feature level fusion, score level fusion, pixel level fusion, and decision level fusion. Any biometric system is capable of producing matching scores for input user with those in the database. The set of all possible user identities can be ranked by sorting the matching scores in the descending order. Thus a biometric system can identify an unknown user by generating ranks, i.e., integer number for each of the user identity. In [32] fingerprint, palmprint and hand geometry are fused using score level. Individual match score of the three modalities are were combined using sum rule. In decision level fusion, the biometric sensors send their final decisions through a communication network that finally fuses these decisions at a fusion center. Comparing to match score level fusion and decision level fusion, feature level fusion contains richer information about multimodel biometrics. So feature level fusion will give better performance[17]. Fusion increases accuracy, but it generally increases template sizes, computation costs and reduces user acceptance.

5. MATCHING

The task of matching is to calculate the degree of similarity between the input test image and a training image from database. Matching can be carried out in three ways: hierarchical approach, classification and coding. Hierarchical approaches employ simple but computationally effective features to retrieve a subset of templates in a given database for further comparison [19]. These approaches increase matching speed at the cost of accuracy. Classification approaches assign a class to each biometric in a database. Many classification methods including KNN classifier [17], nearest neighbor classifier (1-NN) based on the Euclidean space [31] are being used widely. Coding approaches will use one matching function to search entire databases. This avoids errors from the classification or hierarchical systems but it is difficult to identify effective features for the matching function. Hamming distance is used to find out the difference[20].

6. SECURITY AND PRIVACY

Multimodal biometric systems have better accuracy and reliability. But sufficient attention has not been paid to security of multibiometric template. They are vulnerable to attacks including reply, database and brute-force attacks [33]. All the information that is generated by the scanners are stored as templates in the database. So leakage of biometric template information to unauthorized individuals constitutes a serious security issue. Therefore multibiometric template protection [22] should be carried out for security and privacy issues.

7. RESULT ANALYSIS

Comparing to many of the biometric traits existing, palm print and fingerprint give better performance. Table 1 gives a comparison between some of the popular biometric traits like fingerprint, palmprint, face and iris based on certain parameters. Palm print and fingerprint is having low cost and high uniqueness, which makes it more user acceptable. Table 2 gives a comparison study of different methods in the previous researches.

Table 1. Comparison of different biometric traits

Name	**Cost**	**Universatality**	**Uniqueness**	**Permanence**	**Performance**	**Acceptability**	**Circumvention**
Fingerprint	Low	Medium	High	High	High	High	Medium
Palmprint	Low	Medium	Medium	Medium	Medium	Medium	Medium
Facial Recognition	Medium	High	Low	Medium	Low	High	High
Iris	High	High	Medium	High	High	Low	Low

Table 2. Comparison table

Reference	Biometric trait	Method	Advantages	Disadvantages
[5]	Palmprint	Boundary Tracking Algorithm 2D Gabor filter Hamming distance	➢ Good accuracy	➢ Unimodel ➢ Poor feature extraction
[3]	Palmprint Fingerprint	Gaussian low pass filter Short Time Fourier Transform analysis Right angle co-ordinate system Wavelet transform 2-D Gabor filter Normalization Feature level Fusion	➢ Multimodel biometric	➢ Poor feature extraction
[4]	Fingerprint Palmprint Face	Preprocessing(Normalization,Binarization,Histogram equalization,Thinning) Minutiae based feature extraction Score Level matching	➢ Multimodel biometric	➢ Low performance
[23]	Palmprint Fingerprint	Binarization Thinning Noise Reduction Minutiae matching algorithm	➢ Easy ➢ Multimodel biometric	➢ Poor feature extraction method
[17]	Fingerprint Palmprint	Histogram equalization 2D Log Gabor filter Minutiae based feature extraction PCA Wavelet fusion KNN classifier	➢ Multimodel biometric ➢ High user acceptance because of hand based biometric ➢ Better feature extraction method	➢ Log Gabor filter will not give better removal of noise
[16]	Face Iris Fingerprint	PCA Rank Level Fusion	➢ Fast	➢ Less Performance because of Rank Level Fusion
[22]	Fingerprint Iris Face	Embedding algorithm Feature level Fusion Encryption	➢ Lower error rate ➢ Better security	➢ Face has lower uniqueness & Performance

8. CONCLUSION

This paper mainly concentrate on different biometric techniques on fingerprint and palm print. Before concluding some papers are worthy to revise again. For palmprint feature extraction, [35] explains some good techniques called Local Binary Pattern which can extract even the minute details on palmprint. For fusion, feature level fusion is preferred[17]. As researches are concentrated more on extracting features and fusion, parameters like time and speed should also have to be considered. More research should be put into security and privacy issues. Abhishek Nagar and Karthik Nandakumar [22] introduces a better encryption technique for fingerprint, face and iris which can be applied to palmprint and fingerprint also.

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