IOSR Journal of Electronics and Communication Engineering (IOSRJECE)
ISSN : 2278-2834 Volume 2, Issue 6 (Sep-Oct 2012), PP 07-11
www.iosrjournals.org

Multibiometric Identification System Based On Score Level Fusion

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Abstract: *Biometric identification systems, which use physical features to check a person's identity, ensures much greater security than password and number systems. Multibiometric system is being increasingly deployed in much large scale application because they provide lower error rate, large population coverage compared to unibiometric. In this paper, multibiometric identification system aim to fuse iris n fingerprint traits. During enrollment stage system generate iris n fingerprint template separately n stored in database. Approach for fingerprint recognition is to extract minutiae from fingerprint images. It makes possible to achieve highly robust fingerprint recognition for low-quality fingerprints. During iris recognition images are segmented, normalized and features are extract by using Log-Gabor filter. Finally matching is done with help of hamming-distance. Once both iris n fingerprint template are match separately scores are combined by using sum rule-based score level fusion which increase the recognition rate. Thus improve system accuracy and dependability.*
Keywords- *biometric, minutiae extraction, Log-Gabor filter, sum-rule based score level fusion, identification system*

I. Introduction

Establishing the identity of a person is a critical task in any identity management system. Surrogate representations of identity such as passwords and ID cards are not sufficient for reliable identity determination because they can be easily misplaced, shared, or stolen. Biometric recognition is the science of establishing the identity of a person using his/her anatomical and behavioral traits. Commonly used biometric traits include fingerprint, face, iris, hand geometry, voice, palmprint, handwritten signatures. Three features that influenced the increased interest in the biometric are as follows: 1) public acceptance; 2) new user-friendly capture devices with broad improved capabilities; and 3) a broadened range of applications.

In unibiometric systems (based on single biometric trait) has several drawbacks like noisy sensor data, non- universality or lack of distinctiveness of the biometric trait, unacceptable error rates, and spoof attacks. Multimodal biometric systems which combine multiple biometric samples, or characteristics derived from samples, have been developed in order to overcome those problems. Multibiometrics offers the following main advantages: 1) significantly improving the accuracy of the biometric identification or verification; 2) providing a certain degree of flexibility for some unusable biometric traits; and 3) resisting spoof attacks due to the difficulty in spoofing multiple biometric sources.

There are five major components in a generic biometric authentication system, namely, sensor, feature extractor, template database, matcher, and decision module. Sensor is the interface between the user and the authentication system and its function is to scan the biometric trait of the user. Feature extraction module processes the scanned biometric data to extract the feature sets. During enrollment, the extracted feature set is stored in a database as a template by the user's identity information. The matcher module is accepts two biometric feature sets from template and query, resp. as inputs, and outputs a match score indicating the similarity between the two sets. Finally, the decision module makes the identity decision.

The key to multimodal biometric system is the fusion of various biometric modality data. In a multimodal biometric system that uses iris and fingerprint biometric traits, fusion can be done at different levels of information are: (a) feature extraction module, (b) matching module, and (c) decision-making module .

The paper is organized as follows. Section II present the over view of literature. Section III gives information about existing techniques for multimodal biometric authentication system. Section IV describes the proposed multimodal biometric system. Finally some conclusions are reported in Section V.

II. Literature Review

A variety of articles can be found which propose different approaches for unimodal and multimodal biometric systems. Traditional unimodal biometric systems have many limitations.

M. Vatsa[8] introduces nonideal iris segmentation using mumford shah functional. Miyazawa *et al.* [9] performed phasebased image matching using 2-D discrete Fourier transforms. Concerning iris recognition systems in [10] iris images were analyzed by a 1-D dyadic wavelet transform in different resolution levels. With a zero-crossing representation, the feature vector of the iris image was extracted from the wavelet results. The comparison of two feature vectors was carried out by evaluating the dissimilarity with two alternative measurements. Prince [11] deal with pores for matching with template. With the local pore model, a SIFT algorithm is used to match the pores with template. The fingerprint verification system is presented in [23] is based on a a novel robust secure fingerprint matching technique, which is secure against side channel attacks.

Generally, unimodal biometric recognition systems present different drawbacks due its dependency on the unique biometric feature. For example, feature distinctiveness, feature acquisition, processing errors, and features that are temporally unavailable can all affect system accuracy. A multimodal biometric system should overcome the aforementioned limits by integrating two or more biometric features.

A.Gunatilaka [3] proposed fusion of face n fingerprint based on decision level fusion technique using new robust normalization scheme (Reduction of High-scores Effect normalization).Conti *et al*. [12] proposed a multimodal biometric system using two different fingerprint acquisitions. The matching module integrates fuzzy-logic methods for matching-score fusion. Experimental trials using both decision-level fusion and matching-score-level fusion were performed using two different fingerprint acquisitions. Besbes *et al.* [13] proposed a multimodal biometric system using fingerprint and iris features. They use a hybrid approach based on: 1) fingerprint minutiae extraction and 2) iris template encoding through a mathematical representation of the extracted iris region. This approach is based on two recognition modalities and every part provides its own decision. The final decision is taken by considering the unimodal decision through an "AND" operator. Kumar et al proposed a multimodal approach for palmprint and hand geometry, with fusion methods at the feature level by combining the feature vectors by concatenation, and the matching score level by using max rule. T.C. Sabareeswari [15] developed multimodal biometric system possesses a number of unique qualities, starting from utilizing principal component analysis and Fisher's[16] linear discriminate methods for individual matchers (face, ear, and signature) identity authentication and utilizing the novel rank-level fusion method. Yang and Ma [17] used fingerprint, palm print, and hand geometry to implement personal identity verification. Unlike other multimodal biometric systems, these three biometric features can be taken from the same image. They implemented matching score fusion at different levels to establish identity, performing a first fusion of the fingerprint and palm-print features, and successively, a matching-score fusion between the multimodal system and the palm-geometry unimodal system.

Comparing the approaches found in literature and detailed earlier, we introduces an innovative idea using two different strong features—the fingerprint and the iris. Extract the feature from iris and fingerprint separately and then combine them using match score level fusion technique.

III. Existing Methodology

There are basically three technique of fusion technique which can be used for combining two or more biometric features like face ,iris ,fingerprint. These are : (a) fusion at the feature extraction level [3],[20], (b) fusion at the matching score level [21], (c) fusion at the decision level [3],[7].

(a)Fusion at the feature extraction level: The data obtained from each sensor is used to obtained a feature vector. Features extracted from one biometric trait are independent of those extracted from the other. These features are then combine to form one template.

(b) Fusion at the matching score level: Each system provides a matching score indicating the proximity of the feature vector with the template vector. These scores can be combined to assert the veracity of the claimed identity.

©*Fusion at the decision level:* Each sensor can capture multiple biometric data and the resulting feature vectors individually classified into the two classes–accept or reject .

Score level fusion is commonly preferred in multimodal biometric systems because matching scores contain sufficient information to make genuine and impostor case distinguishable and they are relatively easy to obtain. Given a number of biometric systems, matching scores for a pre-specified number of users can be generated even with no knowledge of the underlying feature extraction and matching algorithms of each system. Therefore, combining information obtained from individual modalities using score level fusion seems both feasible and practical. Since the scores generated by a biometric system can be either similarity scores or distance scores, one needs to convert these scores into a same nature.

Let X denote these to raw matching scores from a specific matcher, and let $x \epsilon X$. The normalized score of x is then denoted by x' . These normalization schemes can be used to both sum rule-based fusion and SVM- based fusion for improving accuracy.

Min–max normalization: This normalization[15] maps the raw matching scores to interval [0, 1] and retains the original distribution of matching scores except for a scaling factor. Given that max(X) and min(X) are the maximum and minimum values of the raw matching scores, respectively, the normalized score is calculated as

$$x' = \frac{x - \min(X)}{\max(X) - \min(X)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

IV. Proposed Multimodal Biometric System

Multibiometric offers many advantages like 1)significantly improving the accuracy of biometric identification or verification;2)providing certain degree of flexibility for some unusable biometric traits; and 3)resisting proof attacks due to difficulty in spoofing multiple biometric sources.

The system is composed of number of subsystems, which corresponds to fingerprint recognition and iris recognition, matching using hamming distance. Once matching scores are generated they are normalized using max- min method and then fused by sum rule based fusion.

1.1Fingerprint recognition: One of the methods towards verifying a fingerprint is to find out the minutiae in the image of a fingerprint. The two features of a minutia are ridge endings and bifurcation points. A ridge ending is the point where a ridge ends, and a bifurcation point is where two ridges meet and continue as a single ridge (or conversely a single ridge splits into two ridges).

Fingerprint recognition involves the following four steps :

(a)pre-processing : The pre-processing of the image involves taking the image and applying various processes on the image so that it can easily be processed to find out the ridge endings and bifurcation points. The two major steps in the pre-processing are:

1. Binarizing : In this step the colours of the image are binarized so that the output image consists of only two colours, black and white.

2. Thinning : After the fingerprint image is converted to binary form, submitted to the thinning algorithm which reduces the ridge thickness to one pixel wide.

(b)Minutiae extraction : The most commonly employed method of minutiae extraction is the Crossing number (CN) concept. This method involves the use of the skeleton image where the ridge flow pattern is eight-connected. The minutiae are extracted by scanning the local neighbourhood of each ridge pixel in the image using a 3*3 window. The CN value is then computed, which is defined as half the sum of the differences between pairs of adjacent pixels in the eight-neighbourhood. Using the properties of the CN as, the ridge pixel can then be classified as a ridge ending, bifurcation or non-minutiae point.

(c)Post-processing : False minutiae may be introduced into the image due to factors such as noisy images, and image artifacts created by the thinning process. Hence, after the minutiae are extracted, it is necessary to employ a postprocessing stage in order to validate the minutiae. Figure 5.2 illustrates some examples of false minutiae structures, which include the spur, hole, triangle and spike structures. It can be seen that the spur structure generates false ridge endings, where as both the hole and triangle structures generate false bifurcations. The spike structure creates a false bifurcation and a false ridge ending point. On striates that the global thresholding technique is effective in separating the ridges (black pixels) from the valleys (white pixels). The results of thinning show that the connectivity of the ridge structures is well preserved, and that the skeleton is eight-connected throughout the image.

(d)Fingerprint matching: We calculate the matching score between two images using hamming distance.

1.2 Iris recognition: a unique significant characteristic of the iris is that, no two irises are similar, even for identical twins, among the human population.

(a)Iris segmentation: It is a significant module in iris recognition. It comprises of two steps 1) Estimation of iris boundary by using canny edge detection technique and 2) Noise removal by using Hough transform. The iris image is first fed as input to the canny edge detection algorithm that produces the edge map of the iris image for boundary estimation. The exact boundary of pupil and iris is located from the detected edge map using the Hough transform.

(b)Iris normalization: Daugman`s Rubber Sheet Model is utilized for the transformation process.

(c)Feature extraction: The normalized 2D form image is disintegrated up into 1D signal, and these signals are made use to convolve with 1D Gabor wavelets. The frequency response of a Log-Gabor filter is as follows,

$$\mathrm{G}(f) = \exp\left(\frac{-\left(\log\left(\frac{f}{fo}\right)\right)^{\wedge}2}{2\left(\log\left(\frac{\sigma}{fo}\right)\right)^{\wedge}2}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where f_o indicates the centre frequency and σ provides bandwidth of the filter. The Log-Gabor filter generates the biometric feature (texture properties) of the iris.

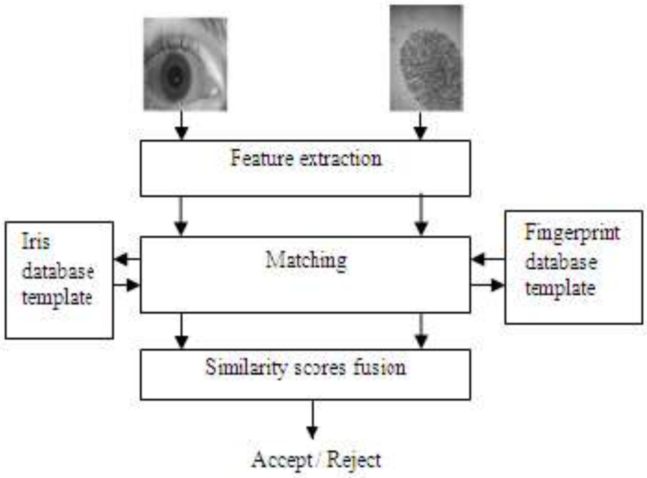

Fig.1. Schematic of the proposed multimodal system.

(d)Matching: The matching score is calculated through the hamming distance.

1.3 Sum-rule based fusion: The procedure for sum rule-based fusion[14] is stated in the following. After we get a set of normalized scores(x_1,….,x_m) from a particular person(here the index i=1,….,m indicates the biometric matcher), the fused score *fs* is evaluated using the formula

$fs = w_1x_1 + \ldots + w_mx_m$ ……………………...(3)

The notation w_i stands for the weight which is assigned to the matcher–i, for i=1,…, m. There are many choices of how to calculate these weights Based on some preliminary results, we decided to use equal weights in our experiments. Then simplified to

$fs = x_1 + \ldots + x_m$ ....(4)

In the next step, the fused score fs will be compared to a pre- specified threshold t. We declare a person to be genuine if $fs \geq t$, otherwise, we declare him/her an impostor.

V. Conclusion

Unimodal biometric systems fail in case of lack of proper biometric data for a particular trait. It is robust to use multiple biometrics for providing authentication. This paper proposed an efficient algorithm fingerprint recognition. The proposed technique is particularly effective for verifying low-quality fingerprint images that could not be identified correctly by conventional techniques. In iris recognition Log-Gabor filter is effective method than any other technique to extract feature from iris image capture. Finally fusion can be applied to enhance the performance of system and security level. Thus the individual scores of two traits, iris and fingerprint are combined at the matching score level to develop a multimodal biometric authentication system.

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