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Survey on Technique of Multimodal Biometric System

Meenakshi Gupta[1], Aditi Grover[2]

Assistant Professor, Dept. of ECE, Manav Rachna University, Haryana, India

Student, Dept. of ECE, Manav Rachna University, Haryana, India

ABSTRACT: Biometric system are automated method of verify or recognizing the identity of a living person on the basis of some psychological characteristics, like fingerprints, iris, face, ear, voiceprint, palm print, signature, or some aspects of behavior, like handwriting or keystroke patterns. A unimodal biometric system has the limited accuracy. In order to improve the accuracy, multimodal biometric systems are widely used. A multimodal biometric system consolidates the result obtained from two or more biometric traits. The most prominent implications of this are increased accuracy, fewer enrollment problems, and enhanced security. In this paper we present a brief overview of multimodal biometric system, their advantages and disadvantages, and review of work based on uncorrelated modalities.

KEYWORDS: Biometric Systems, Verification, Identification, Biometric Fusion.

I. INTRODUCTION

Biometrics, which refers to automatic identification of a person based on her physiological or behavioral characteristics [1], is inherently more reliable and more capable in differentiating between an authorized person and a fraudulent impostor than traditional methods such as passwords and PIN numbers. A *biometric system* is essentially a pattern recognition system which makes a personal identification by determining the authenticity of the specific physiological or behavioral characteristic possessed by the user. It can be based on either a (or one snapshot of a) single biometric characteristic or multiple biometric characteristics (or multiple snapshots of a single biometric characteristic) to make a personal identification. When a biometric system which uses only a single biometric characteristic as a unimodal biometric system, and when a biometric system which uses multiple biometric characteristics as a multimodal biometric system. Some unimodal systems suffer from enrollment problems, biometric spoofing or insufficient accuracy caused by noise data [2]. One of the main differences between the evaluation of unimodal and multimodal biometric systems is the nature of the database used. The performance metrics of a biometric system such as accuracy, throughput, and scalability can be estimated with a high degree of confidence only when the system is tested on a large representative.

In designing a multimodal biometric system, a number of issues need to be considered:

- What is the main purpose of utilizing multiple biometrics?
- What is the operational mode?
- Which biometrics should be integrated?
- How many biometrics are sufficient?

II. LIMITATION OF BIOMETRIC SYSTEM

Biometric Systems are often affected by the following problems.

2.1. Noise in sensed data & Non-universality :The recognition accuracy of the biometric system is highly sensitive to the quality of the biometric input and noisy data. Non-universality leads to failure to Enroll (FTE) error in biometric system.

2.2. Lack of Individuality: Feature extracted from different individuals can be quite similar. This lack of uniqueness increases the False Accept Rate (FAR) of a biometric system.

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2.3. Intra-class variations & Inter-class similarities: The biometric data acquired during verification will not be identical to the data used for generating template during enrollment for an individual. Inter-class similarity refers to the overlap of feature spaces corresponding to multiple individuals.

III. ADVANTAGE OF MULTIMODAL SYSTEM OVER UNIMODAL SYSTEM

Multimodal biometric systems offer several advantages over traditional unimodal biometric systems. Some of these advantages are given below [3, 4].

- It improvement in the matching accuracy of a biometric system.
- FAR and the FRR of the verification system can be reduced simultaneously.
- The capacity of an identification system may be increased in order to accommodate more individuals.
- A certain degree of flexibility is achieved when a user enrolls into the system using several different traits.
- It becomes increasingly difficult (if not impossible) for an impostor to spoof multiple biometric traits of a legitimately enrolled individual.

IV.OPERATIONAL MODE

A biometric system can operate in either a verification mode or an identification mode. Figure 1 and figure 2 show a generic multimodal verification and identification system respectively [5].

4.1. Verification Mode

- Integration of multiple snapshots of a single biometrics, for example, a number of fingerprint images of the same finger in fingerprint verification.
- Only a one-to-one comparison is performed in a verification system,
- Integration of multiple biometric in a verification system is mainly intended to improve the accuracy of the system

4.2. Identification mode

- To perform one-to-many comparisons to find a match so a large number of matching need to be performed to identify an individual.
- Improve the identification accuracy and identification speed.

V. PROCESSING ARCHITECTURE MODE

Figure 3,4 and 5 show the serial, parallel and hierarchical architecture respectively[6].

5.1 Serial Architecture

In the serial or cascade mode, the processing of information takes place sequentially. In such an arrangement, the processing time can be effectively reduced if a decision is made before going through all the biometric subsystems.

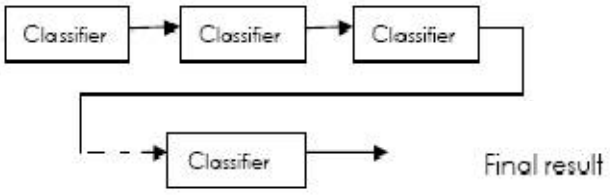

Figure 1. Serial Architecture[6]

5.2 Parallel Architecture

In the parallel mode, on the other hand, each sub-system processes its information independently at the same time and the processed information is combined using an appropriate fusion scheme The cascading scheme can improve user convenience as well as allow fast and efficient searches in large scale identification tasks.

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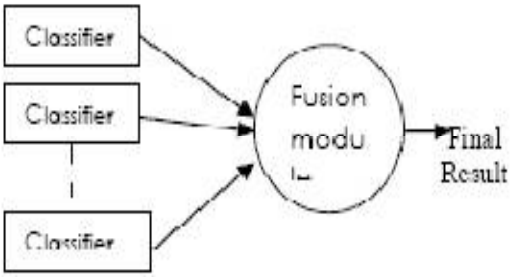

Figure 2. Parallel architecture[6]

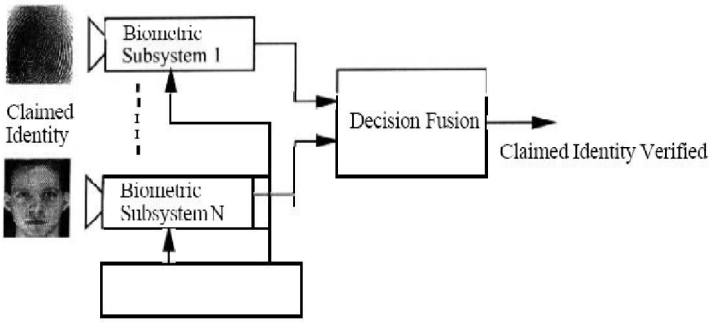

Figure 3. A generic multimodal verification system[5]

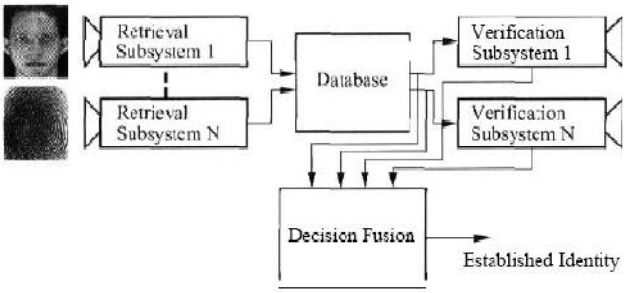

Figure 4. A generic multimodal Identification system[5]

5.3 Hierarchical (tree-like) Architecture

In such a scheme, a subset of the acquired modalities may be combined in parallel, while the remaining modalities may be combined in a serial fashion. Such architecture can be dynamically determined based on the quality of the individual biometric samples as well as the possibility of encountering missing biometric data.

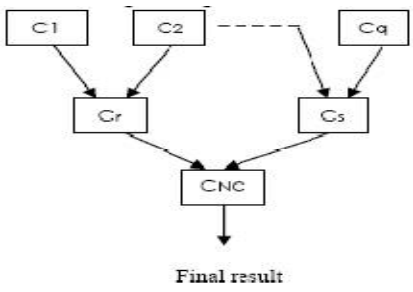

Figure 5. Hierarchical architecture[6]

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VI. FUSION IN BIOMETRICS

In a multibiometric system, fusion can be accomplished by utilizing the information available in any of these modules. Figure 4 indicates the various levels of fusion[7] that are possible in the context of a biometric system. These levels can be broadly classified as:

6.1 Fusion before matching

Prior to matching, integration of information from multiple biometric sources can take place either at the sensor level or at the feature level.

- Sensor level fusion is applicable only if the multiple sources represent samples of the same biometric trait obtained either using a single sensor or different compatible sensors. The raw data from the sensor(s) are combined in *sensor level fusion.*
- *Feature level fusion* refers to combining different feature sets extracted from multiple biometric sources. When the feature sets are homogeneous, a single resultant feature vector can be calculated as a weighted average of the individual feature vectors. When the feature sets are non-homogeneous, concatenate them to form a single feature vector.

6.2 Fusion after matching

After the matching, integration of information from multiple biometric sources can take place either at the match score level, decision level or rank level

- In match score level, each biometric system outputs a match score indicating the proximity of the input data to a template.
- In decision level, each biometric system independently makes a decision about the identity of the user or determines if the claimed identity is true or not.
- In rank level, the output of each biometric system is a subset of possible matches (i.e., identities) sorted in decreasing order of confidence. This is relevant in an identification system where a rank may be assigned to the top matching identities.

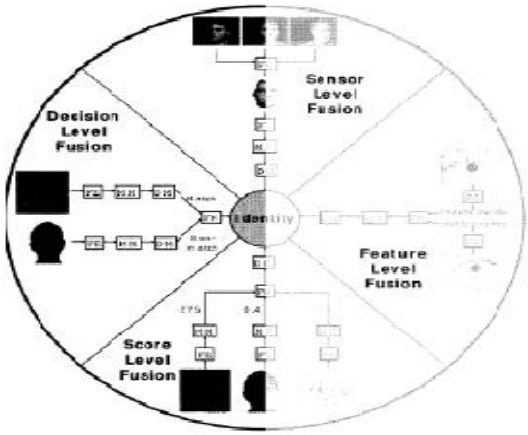

Figure 6. Level of fusion in biometric system [7]

VII. RIVIEW OF WORK

7.1 Ben-Yacoub et al., 1999[8] evaluate a number of classification schemes for fusion of match scores from multiple modalities, including support vector machine (SVM) with polynomial kernels, SVM with Gaussian kernels, C4.5 decision trees, multilayer perceptron, Fisher linear discriminant, and Bayesian classifier. The total error rate of 0.6% achieved by the Bayesian classifier was significantly lower than the total error rate of 1.48% achieved by the HMM based speaker recognition system, which was the best individual modality in terms of total error rate.

7.1.1 Advantage:

- Identification through voice and face is natural and easily accepted by end-users.
- Better comparison between classifiers.

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• Advantages of the elastic graph matching are the robustness against variation in face position, and expression.

7.1.2 Disadvantages:

• Using EGM, when contribute from nodes are considered equally then performance is degraded.
• When the parametric learning fusion strategies are adopted at the match score level, the fusion is viewed as a classification problem.

7.2 Ross and Jain, 2003 [9], this paper addresses the problem of information fusion in biometric verification systems by combining information at the matching score level. Experimental results on combining three biometric modalities (face, fingerprint and hand geometry) are presented. Here the experiment shows that, the sum rule performs better than the decision tree and linear discriminant classifiers. The FAR of the tree classifier is 0.036% (±0.03%) and the FRR is 9.63% (±0.03%). The FAR of the linear discriminant classifier is 0.47% (±0.3%) and its FRR is 0.00%. The FRR value in this case is a consequence of over fitting the genuine class as it has fewer samples in both the test and training sets. The sum rule that combines all three scores has a corresponding FAR of 0.03% and a FRR of 1.78% suggesting better performance than the other two classifiers.

7.2.1 Advantages:

• Better comparison of classifier in terms of performance.
• The benefit of multibiometrics may become even more evident in case of a larger database of users.

7.2.2 Disadvantages:

• Lack of user specific weights for individual modalities.
• When the parametric learning fusion strategies are adopted at the match score level, the fusion is viewed as a classification problem.

7.3 Wang et. Al-2003[10], In this paper, uses two different strategies for fusing iris and face classifiers. The first strategy is to compute either an unweighted or weighted sum and to compare the result to a threshold. The second strategy is to treat the matching distances of face and iris classifiers as a two- dimensional feature vector and to use a classifier such as Fisher's discriminant analysis and a neural network with radial basis function (RBFNN) to classify the vector as being genuine or an impostor
and also compare the results of the combined classifier with the results of the individual face and iris classifier.

7.3.1 Advantages:

• Face recognition is friendly and non-invasive whereas iris recognition is one the most accurate biometrics is used.
• Overcomes a number of inherent difficulties of the standalone classifier.
• Decrease the enrollment failure rate and reduce verification time.

7.3.2 Disadvantages:

• When the parametric learning fusion strategies are adopted at the match score level, the fusion is viewed as a classification problem.

7.4 Liu and Sarkar-2007[11] In this paper, the combination of gait and face can effectively enhance the performance of outdoor biometrics at a distance also demonstrate this for conditions that are known to be ''hard'' in face and gait recognition. Gait and face studies was also presented by authors [12, 13 & 14], but they used either indoor data or outdoor data taken on same day. In this paper consider outdoor data, taken month apart. The primary focus of this paper is to investigate the power of the face and gait biometric fusion. On a gallery database of 70 individuals and two probe sets: one with 39 individuals taken on the same day and the other with 21 individuals taken at least 3 months apart, results indicate that although the verification rate at 1% false alarm rate of individual biometrics are low, their combination performs better. Specifically, for data taken on the same day, individual verification rates are 42% and 40% for face and gait, respectively, but are 73% for their combination. Similarly, for the data taken with at least 3 months apart, the verification rates are 48% and 25% for face and gait, respectively, but are 60% for their combination.

7.4.1 Advantage:

• Explore the possibility of using both face and gait in enhancing human recognition at a distance performance in outdoor conditions.
• Result show that the combination of outdoor gait and one outdoor face per person is superior to using two outdoor face probes per person or using two gait probes per person.

7.4.2 Disadvantage

• The outdoor face recognition and gait recognition across surface conditions have been found to be hard problems.
• Face and gait recognition over time (>3 months apart) is poor
• The stance selection can significantly improve gait recognition but not to a level where just gait

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Suffices.

7.5 Fox and Gross, 2007[15]; In this paper, developed a multiple expert biometric person identification system that combines information from three experts: audio, visual speech, and face. The system uses multimodal fusion in an automatic unsupervised manner, adapting to the local performance (at the transaction level) and output reliability of each of the three experts. To test system robustness to train/test mismatch, we used a broad range of acoustic babble noise and JPEG compression to degrade the audio and visual signals, respectively. Identification experiments were carried out on a 248-subject subset of the XM2VTS database. At severe audio and visual mismatch levels tested, the audio, mouth, face, and tri-expert fusion accuracies were 16.1%, 48%, 75%, and 89.9%, respectively, representing a relative improvement of 19.9% over the best performing expert.

7.5.1 Advantages:

- The audio, face, and mouth modalities contain non redundant, complementary information about person identity.
- Tri-expert performance exceeds the performance of either the audio-mouth or audio-face fusion.
- Using the tri-expert fusion scheme increase the accuracy of audio-face-mouth combination.
- Audio-visual training data is not required to tune the fusion process.
- Important for person recognition applications.

7.5.2 Disadvantage:

- When a modality is unavailable or missed, the multimodal systems break down or the accuracy degrades.

7.6 Wang and Han, (2008) [16] this paper presents a robust multimodal authentication scheme. They proposed multimodal scheme integrates iris, face, and palmprint. These biometric modalities are fused at matching score level. The parallel SVMs cover all possible subsets of the biometric modalities being considered.

7.6.1 Advantages:

- Eliminate the limitation brought by the missing modalities.
- Give the better performance when compared with unimodal system.
- More practical and flexible.

7.6.2 Disadvantages:

- If multiple modalities are not properly combined the performance is degraded

VIII. CONCLUSION

A unimodal biometric system which is based only on a (or one snapshot of a) single biometric characteristic may not always be able to achieve the desire performance. On the other hand, a multimodal biometric modality can significantly improve the recognition accuracy of a verification/identification system. In multimodal biometric system, fusion at the score level is most important and widely used because it offers the best tradeoff between information content and ease of fusion. A combination of uncorrelated modalities offers some advantages over combination of correlated modalities:

1. Results are better in term of performance.
2. Reduce the failure to enroll rate.
3. Provide more security against fraud.

We can design a hybrid system for example combination of multi algorithmic and multimodal, obtain the better result.

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BIOGRAPHY

Meenakshi born on November 15, 1983, received her B.Tech (Electronics Communication) from NIET, UPTU, Greater Noida in the year 2005.Her M.Tech. (VLSI Design) from Banasthali Vidyapeeth , Rajasthan in 2008. She is pursuing Ph.D (microelectronics) from Bhagwant University.

She is, presently, working as Asst. Professor in the Department of Electronics & Communication Engineering at Manav Rachna University, Faridabad.

Aditi Grover born on January 10, 1995 in Delhi, India, is a single child of a noble and well educated family. She matriculated from St. Anthony's Secondary School, Faridabad in 2011 with CGPA 10.She did her 12th (Non-Medical) from MVN School ,Sector- 17,Faridabad in 2013.
She is presently pursuing B.Tech in "Electronics and Communication" from Manav Rachna University.