



A Study on Multimodal Biometrics System

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Abstract

Recently there has been an extensive growth in the use of biometrics for person identification applications. Biometrics which is defined as anatomical / physiological (fingerprint, iris, face) and behavioural (ridges, gait) characteristics are used by FBI (Federal Bureau of Investigation), law enforcement and intelligence departments for the identification or authentication of an individual. Biometric identification systems which use a single biometric trait of the individual for identification and verification are called unimodal systems. Biometric identification systems which use or are capable of using a combination of two or more biometric modalities to identify an individual are called multimodal biometric systems. The most important reason behind using multimodal biometric systems is these systems depend on multiple sources of information and thereby improve the recognition rate. In order to choose multimodal biometric technology for identification a study on multimodal biometric system is required. This paper presents an overview of multimodal biometrics system.

Keywords: Biometrics, FBI, Unimodal, multiple source, Multimodal, recognition.

1. Introduction

Biometrics is the technical term for body measurements and calculations. It refers to metrics related to human characteristics. Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control.^[1] It is also used to identify individuals in groups that are under surveillance. Biometric identifiers are then distinctive, measurable characteristics used to label and describe individuals.^[2] Biometric identifiers are often categorized as physiological versus behavioral characteristics.^[3] Physiological characteristics are related to the shape of the body. Examples include, but are not limited to fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina and odour/scent. Behavioral characteristics are related to the pattern of behavior of a person, including but not

limited to typing rhythm, gait,^[4] and voice.^[5] Some researchers have coined the term behaviometrics to describe the latter class of biometrics.^[6]

1.1 Unimodal Biometric systems

Biometric identification systems which use a single biometric trait of the individual for identification and verification are called unimodal systems.

1.2 Multimodal biometric systems

Biometric identification systems which use or are capable of using a combination of two or more biometric modalities to identify an individual are called multimodal biometric systems. The block diagram of multimodal biometric system is shown in figure 1

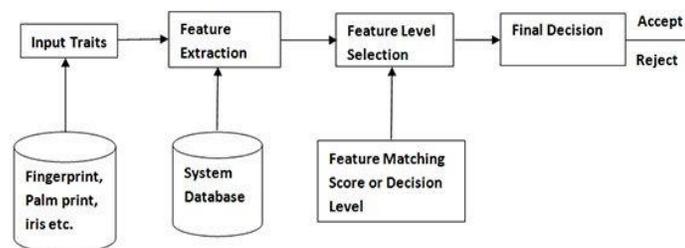


Figure.1 Block diagram of multimodal biometric system

2. Multimodal biometric system

Biometric systems which rely on Unimodal authentication system rely on single source of information like face, fingerprint, voice, gait, iris, retina, etc.. These systems lack level of accuracy due to noisy data, intra-class variations, inter-class similarities, non-universality and spoofing. It leads to considerably high false acceptance rate (FAR) and false rejection rate (FRR), limited discrimination capability, upper bound in performance and lack of permanence [7]. These disadvantages imposed by unimodal biometric systems can be overcome by including multiple sources of information for establishing identity. These systems allow the integration of two or more types of biometric systems known as multimodal biometric systems. These systems are more reliable due to the presence of multiple, independent

biometrics [8]. These systems are able to meet the stringent performance requirements imposed by various applications. They address the problem of non-universality, since multiple traits ensure sufficient population coverage. They also deter spoofing since it would be difficult for an impostor to spoof multiple biometric traits of a genuine user simultaneously. Furthermore, they can facilitate a challenge – response type of mechanism by requesting the user to present random subset of biometric traits thereby ensuring that a ‘live’ user is indeed present at the point of data acquisition.

2.1 Process of Multimodal Biometric Systems

The major steps involved in multimodal biometric systems are

- Acquisition
- Feature extraction
- Comparison
- Decision making
- Fusion process

The fusion process to integrate the information from two different authentication systems can be done at any of the following levels –

- During feature extraction.
- During comparison of live samples with stored biometric templates.
- During decision making.

Figure 2 shows how multimodal biometric system works.

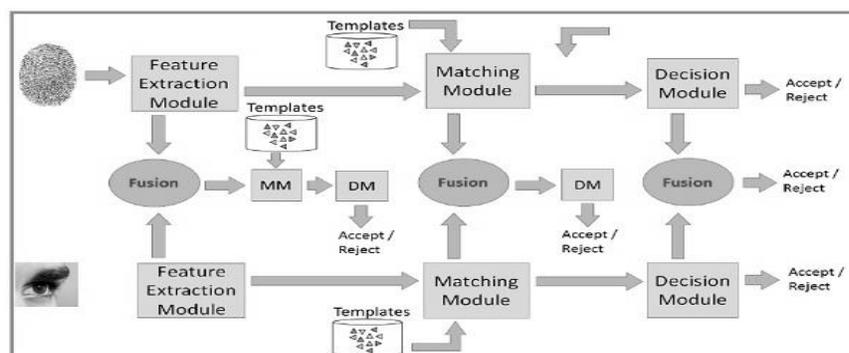


Figure 2: Working of multimodal biometric systems



If the fusion process is done at initial stage are considered to be more effective than the systems those integrate the information at the later stages. The reason is the early stage contains more accurate information than the matching scores of the comparison modules.

3. Fusion levels in multimodal biometric system

3.1 Fusion at data or feature level, (data/features)

Signals coming from different traits are preprocessed and then fusion specific algorithm is used to obtain composite feature vector, which is again used for classification.

3.2 Fusion at the match score level.

Instead of combining feature vectors each matching is done individually then fusion is done to obtain composite matching score

3.3 Fusion at the decision level.

The final outputs of multi classifiers are consolidated. Fusion at the match score is preferred. The fusion improves performance, accuracy reliability, robustness, efficiency, fault tolerance. Figure 3 below depicts the fusion levels in multimodal biometrics system.

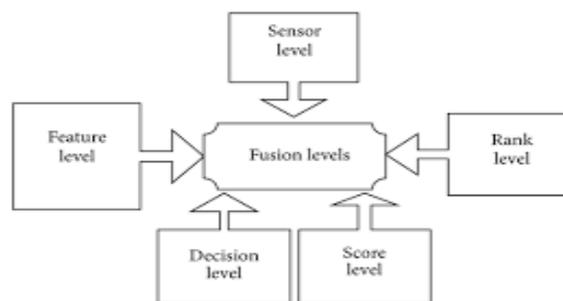


Figure 3: Fusion levels in multimodal biometrics system

Biometric systems that integrate information at an early stage of processing are believed to be more effective than those systems which perform integration at a later stage. The reasons are i) Feature set from various modalities may not be compatible. ii) Most commercial biometric systems do not provide access to feature sets. Fusion at decision level is considered rigid due to availability of limited information. Thus, fusion at match score level is usually preferred[9]



4. Fusion Scenarios in Multimodal Biometric System

Within a multimodal biometric system, there can be variety in number of traits and components. They can be as follows –

- Single biometric trait, multiple sensors.
- Single biometric trait, multiple classifiers (say, minutiae-based matcher and texture-based matcher).
- Single biometric trait, multiple units (say, multiple fingers).
- Multiple biometric traits of an individual (say, iris, fingerprint, etc.).

These traits are then operated upon to confirm user's identity. [10]

5. Applications

The defense and intelligence communities require automated methods capable of rapidly determining an individual's true identity as well as any previously used identities and past activities, over a geospatial continuum from set of acquired data. A homeland security and law enforcement community require technologies to secure the borders and to identify criminals in the civilian law enforcement environment. Key applications include border management, interface for criminal and civil applications, and first responder verification. Enterprise solutions require the oversight of people, processes and technologies. Network infrastructure has become essential to functions of business, government, and web based business models. Consequently securing access to these systems and ensuring one's identity is essential. Personal information and Business transactions require fraud prevent solutions that increase security and are cost effective and user friendly. Key application areas include customer verification at physical point of sale, online customer verification etc.[11-13]

6. Conclusion

This paper presents the study on multimodal biometric systems in an expectation that future biometrics applications will use multiple biometric modalities so that the performance of identification will be improved with a good accuracy level. To conclude, as biometrics is popularly effective for person identification in various levels of implementation it can be made more effective by combining more than one biometric traits , that is multimodal biometric systems. Such systems is expected to be unavoidable in the coming future.



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