

# **Multimodal Biometrics: An Overview**

**Arun Ross and Anil K. Jain**

**Presented by : Nawaf Ali  
University Of Louisville**

# Abstract

Limitations and problems that you can face when applying Unimodal Biometric system such as noisy data, intra-class variations, restricted degree of freedom, non-universality, spoof attacks, and unacceptable error rates , can be addressed by deploying a multimodal biometric system.

There are various scenarios that are possible in multimodal biometric systems, and level of fusion that are plausible and the integration strategies that can be adopted to consolidate information.

# Introduction

Establishing the identity of a person is becoming critical in our vastly interconnected society. Is it really you who you are claiming to be? Or is it really that you are not the person who you are claiming not to be?

The need for a reliable user authentication techniques has increased in the wake of heightened concerns about security and rapid advancement in Networking.

# Introduction contd.

Most biometric systems deployed in real world applications are Unimodal, i.e., single finger print, or a face. These systems have to contend with a variety of problems:

- a) Noise in sensed data.
- b) Intra-class variations.
- c) Inter-class similarities.
- d) None Universality.
- e) Spoof Attacks.

# Introduction contd.

Some of these limitations can be overcome by multiple source of information for establishing identity, such systems are known as multimodal biometric systems. They address the problem of non-universality since multiple traits ensure sufficient population coverage. Also for spoofing problem, it would be difficult for an imposer to spoof multiple biometric traits at the same time. Random subset of biometric trait would make it even harder for spoofing.

# Level of Fusion

A generic biometric system has 4 main modules:

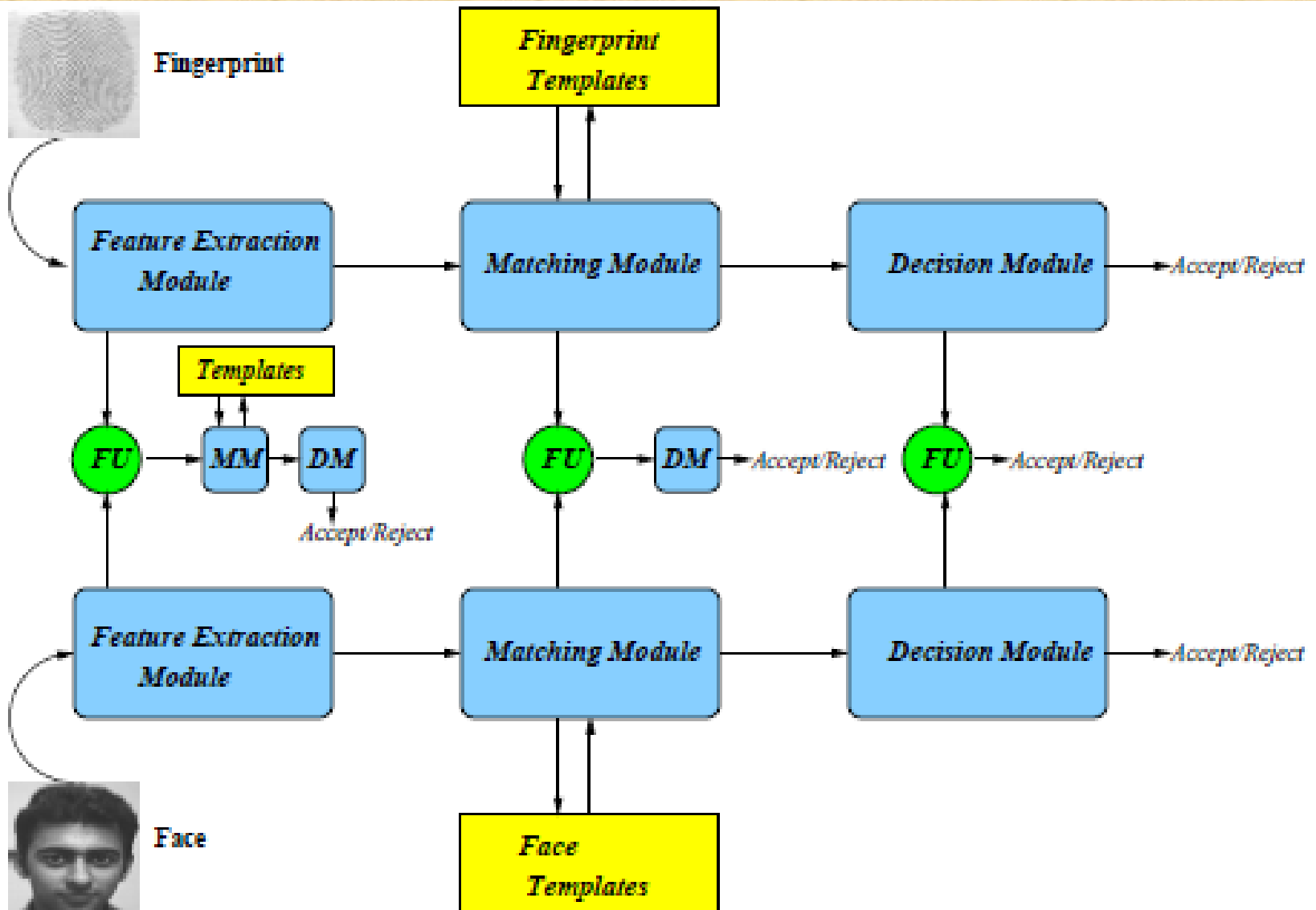
- a) Sensor module.
- b) Feature extraction module.
- c) Matching module.
- d) Decision module.

# **Level of Fusion contd.**

**In a multimodal biometric system, information reconciliation can occur in any of the previously mentioned modules:**

- a) Fusion at data or feature level, (data/features).**
- b) Fusion at the match score level.**
- c) Fusion at the decision level.**

**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.**



Level of Fusion in a bimodal biometric system

FU: Fusion Module, MM: Matching Module, DM: Decision Module.



# **Level of Fusion contd.**

**However, fusion at early stage is difficult to achieve in practice because:**

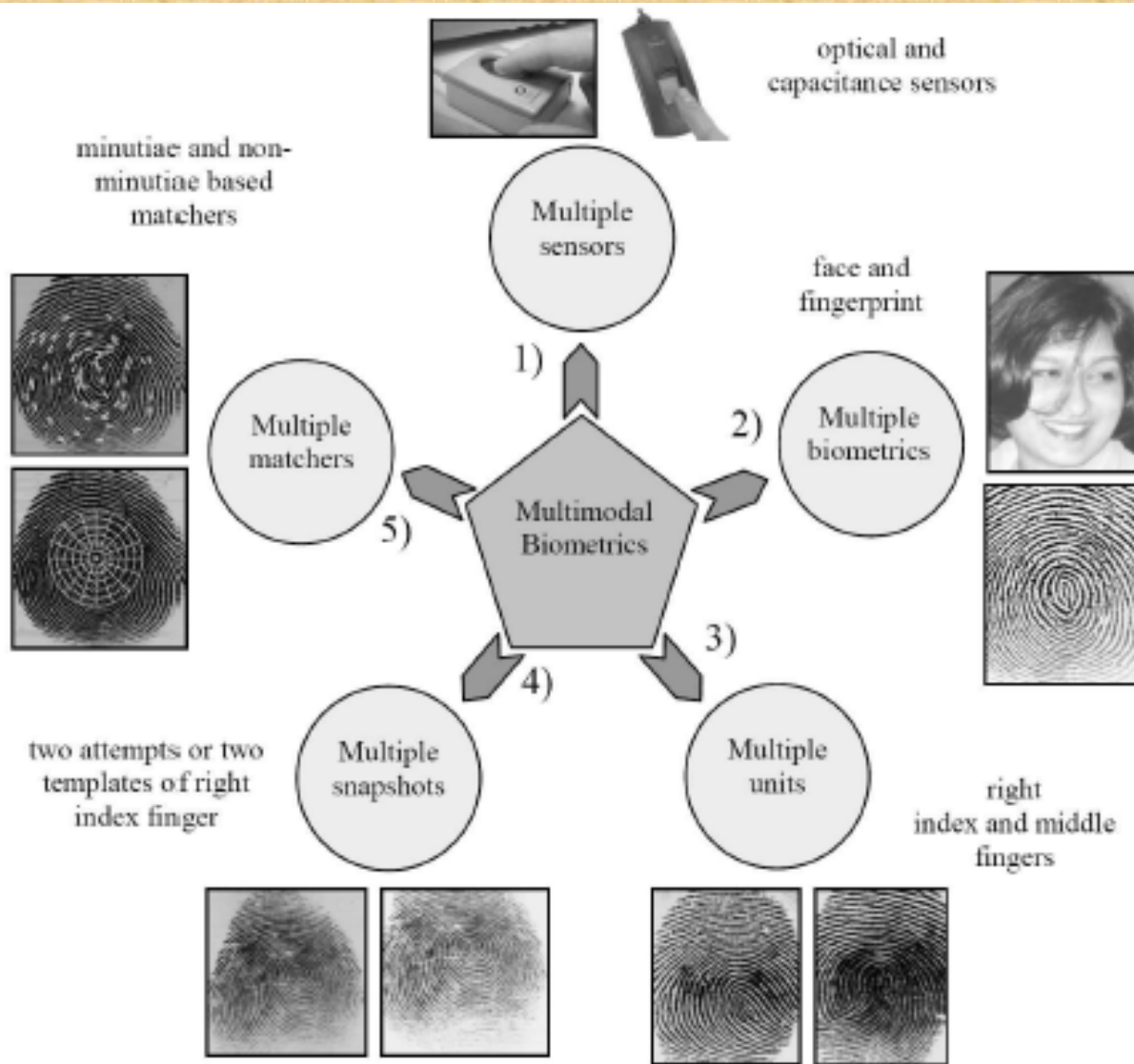
**I) Feature set from various modalities may not be compatible.**

**II) Most commercial biometric systems do not provide access to feature sets.**

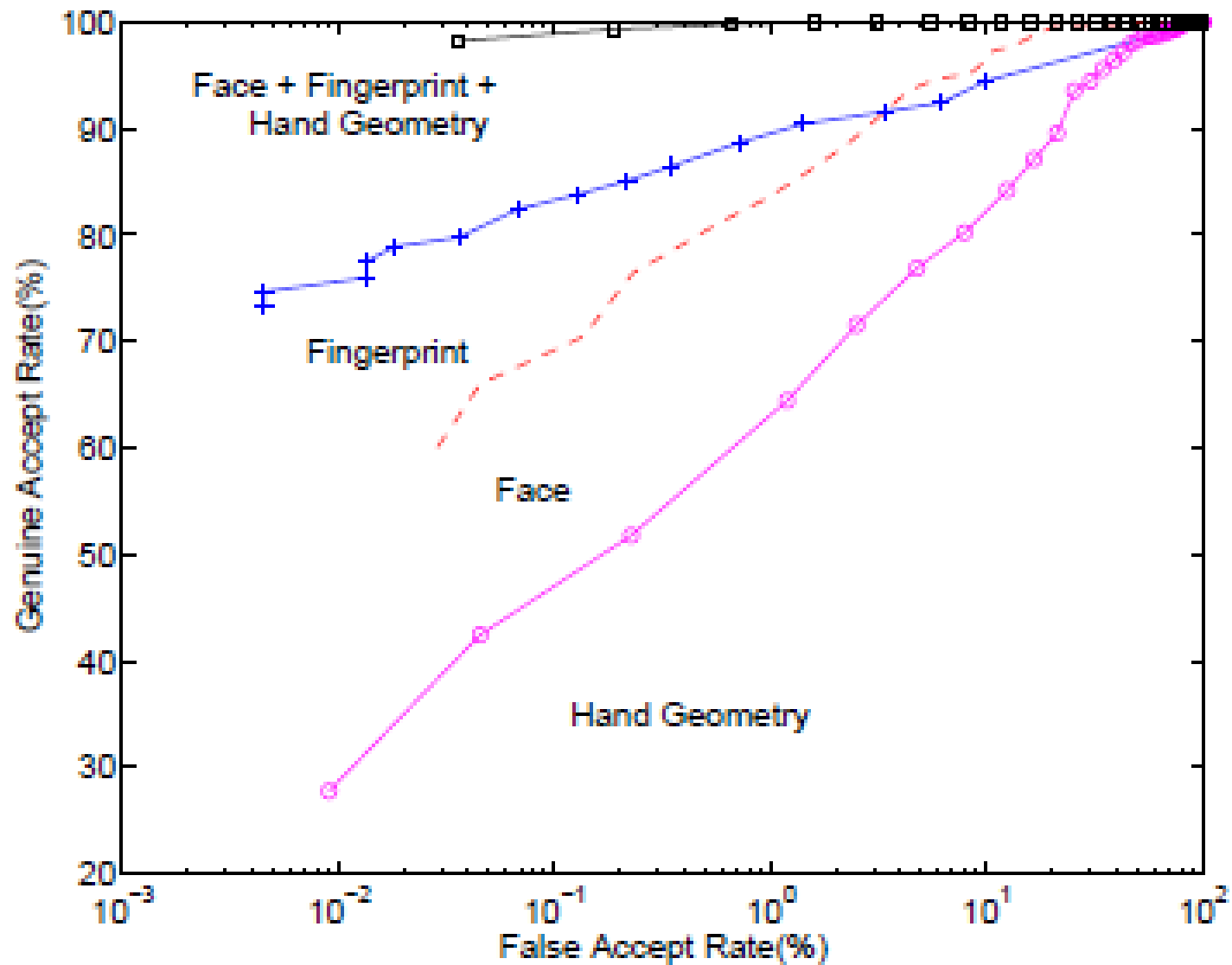
**Fusion at decision level is considered rigid due to availability of limited information. Thus, fusion at match score level is usually preferred.**

# Fusion scenarios

1. Single biometric trait, multiple sensors.
2. Single biometric trait, multiple classifiers.
3. Single biometric trait, multiple units.” two fingers, both irises”.
4. Multiple biometric traits.



**Scenarios in a multimodal biometric system**



Performance gain using the sum rule.

# Modes of operation

- Serial mode: narrow down the number of possible identities. Decision can be made early.
- Parallel mode.
- Hierarchical mode: individual classifiers are combined in a tree like structure, for large number of classifiers.

# Integration strategies

Depending on the level of fusion.

- Feature level fusion can be accomplished by concatenating two compatible feature sets.
- Fusion at match score level can be done by two approaches:
  - a) Fusion is viewed as classification problem, where a feature vector is constructed using matching score output by individual matchers.
  - b) Fusion is viewed as combination problem, where the individual matching scores are combined to generate a single scalar score.

# Design issues

Factors to take into consideration when designing a multimodal biometric system:

- Choice and number of biometric traits.
- The level in the biometric system in which information should be integrated.
- Methodology adopted for integration .
- Cost versus matching performance.

# Conclusion

Applying the multimodal biometric systems solved several problems presented in the unimodal systems. It did improve matching performance, increase population coverage, deter spoofing and facilitate indexing.

Fusion at the match score level is the most popular due to ease in accessing and consolidating matching scores. The incorporate user-specific parameters can improve performance.



**Questions??**