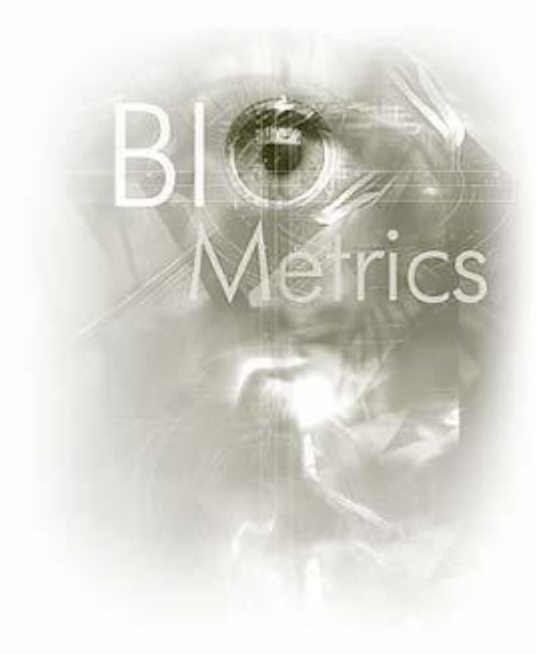
Introduction to Biometrics



Outline

- Introduction
- Biometrics Definition
- Biometric Characteristics
- Examples of Biometric Traits: Fingerprints, Face, Iris, Gait
- Comparison of Biometric Technologies
- Operation of a Biometric System: Enrollment, Verification, Identification
- Conclusion

Introduction (Definition of Terms)

Face

Fingerprint

Identification – associating an identity with an individual

Two types of identification problems:

- Verification – confirming or denying a person's identity, i.e., Am I who I claim I am?
- Identification – establishing identity, i.e., Who am I?

Introduction (Background)

- In 2006, fraud in the United Kingdom alone was estimated at £535 million, or US$750–830 million at prevailing 2006 exchange rates.
- Afghan insurgency – hinder militant movement around the country, and to keep Taliban infiltrators out of the army

Biometrics Definition

Biometrics – the science of establishing the identity of an individual based on physical, chemical, or behavioral attributes of the person[1]

[1]Jain, Anil K.; Flynn, Patrick; Ross, Arun A. (Eds.), "Handbook of Biometrics," Springer, 1 ed. (August 31, 2007)

Biometric Characteristics

Jain et al.[2] have identified seven factors that determine the suitability of a physical or a behavioral trait to be used in a biometric application.

- **Universality** – everyone should have it
- **Uniqueness** – small probability that two persons are the same with this characteristic
- **Permanence** – invariance with time
- **Collectability** – can be measured quantitatively
- **Performance** – high identification accuracy
- **Acceptability** – acceptance by people
- **Circumvention** – how easy to fool the system by fraudulent techniques

[2]A. K. Jain, R. Bolle, and S. Pankanti, editors. Biometrics: Personal Identification in Networked Society. Kluwer Academic Publishers, 1999.

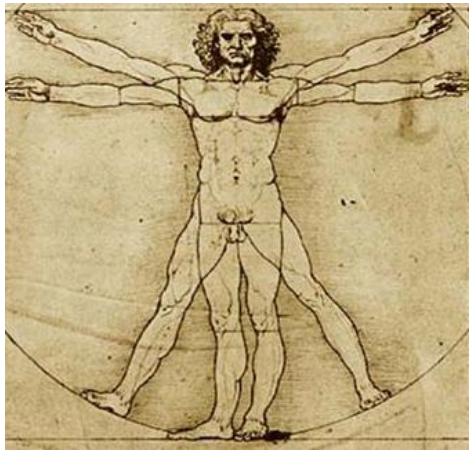
Examples of Biometric Traits


Signature


Gait

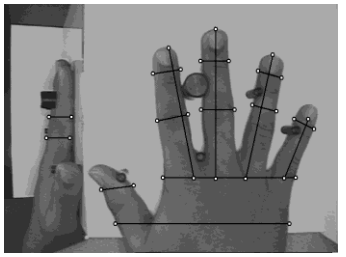

Fingerprint

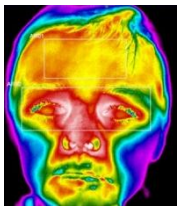

Ear



Face

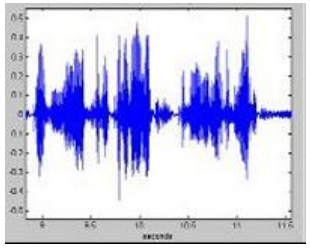

Iris


Hand Geometry


Facial Thermogram

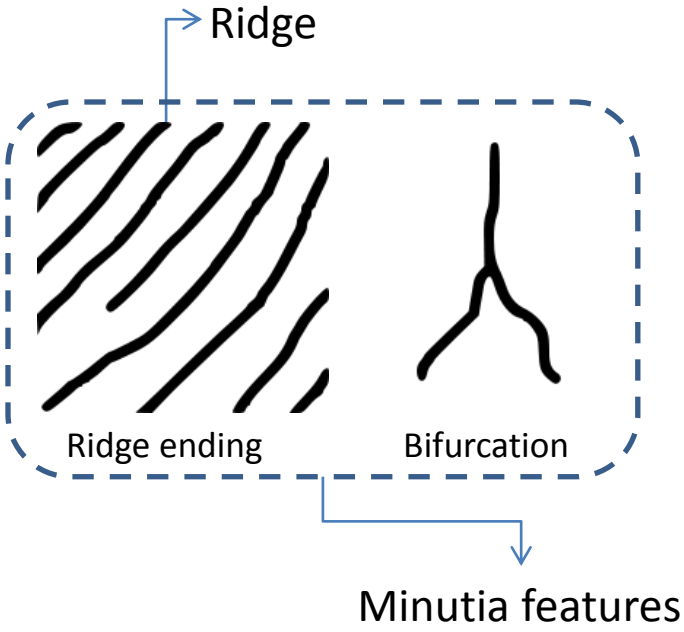
Keystroke Dynamics

Voice



Vein Pattern

Examples of Biometric Traits: Fingerprints



Fingerprints – graphical flow-like ridges

- formation determined during the first 7 months of fetal development
- empirically determined that fingerprints of identical twins are different

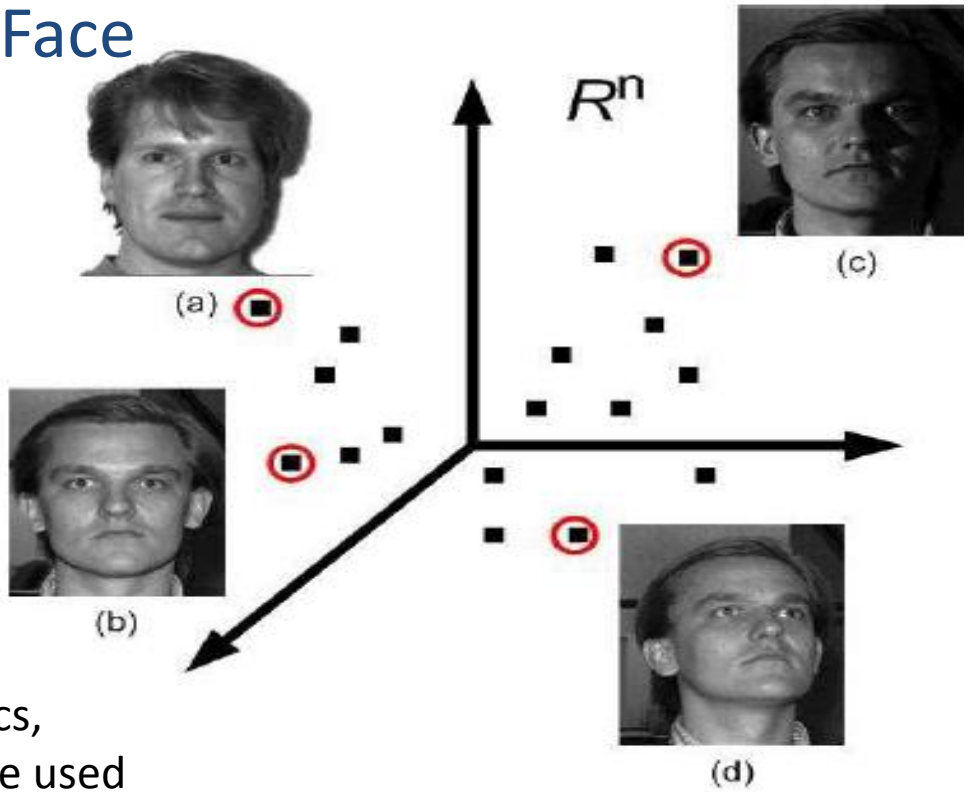
Major representations

- image, ridges, minutia (features derived from ridges), pores

Basic approaches to identification

- correlation-based, global ridge patterns (classes), etc.

Examples of Biometric Traits: Face



Face – one of the most acceptable biometrics, most common biometric feature to be used by humans to recognize

– non-intrusive

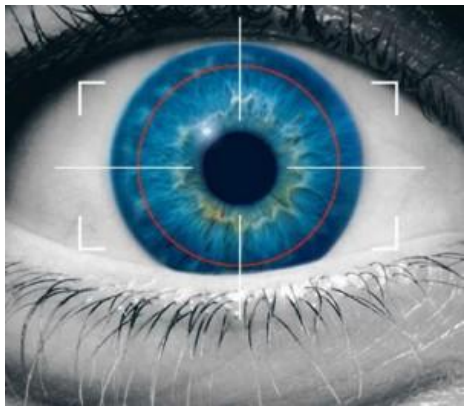
Factors that influence recognition:

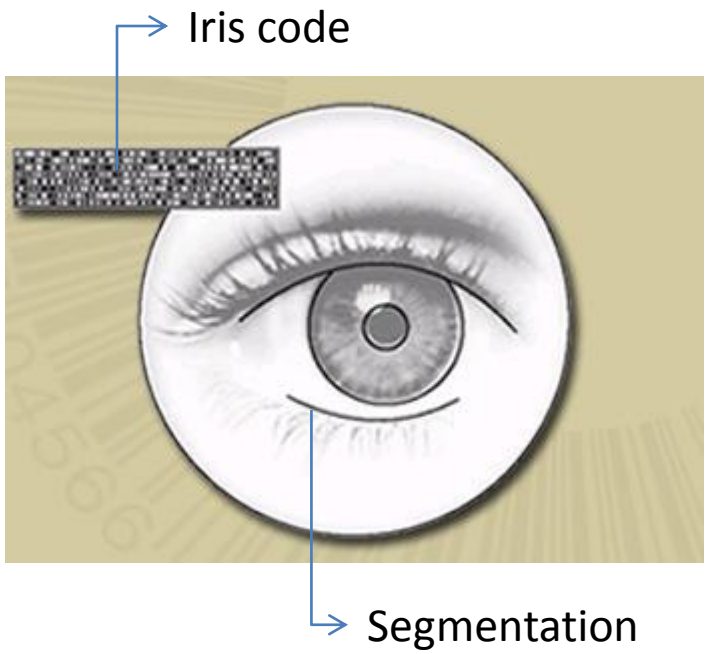
- Facial disguise
- Facial expression
- Lighting conditions
- Pose variation

Basic approaches to identification

- Transform-based (PCA, LDA)
- Attributes-based (EBGM)

Examples of Biometric Traits: Iris





Iris – one of the most reliable biometrics

Frontal images are obtained using near-infrared camera (320x480 pixels) at distance < 1 meter

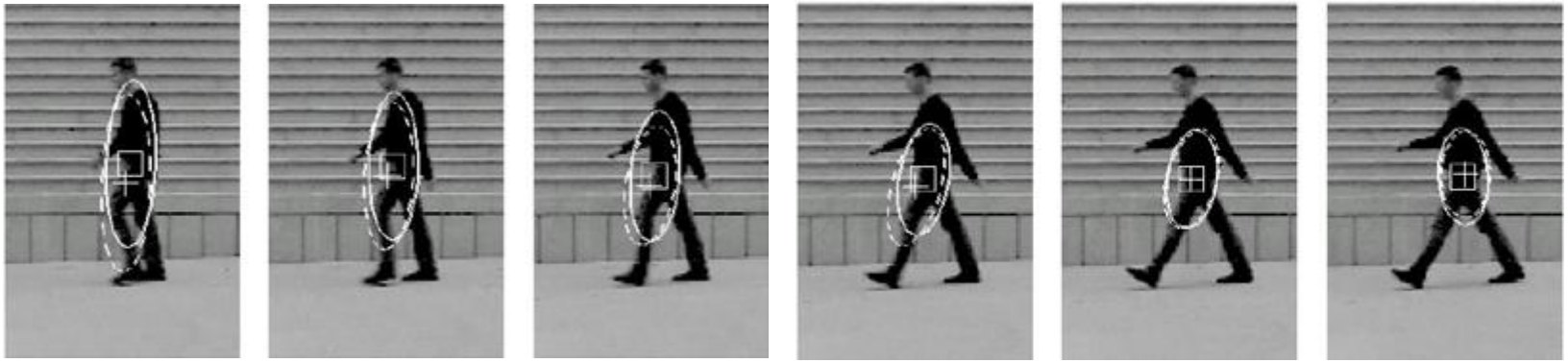
- **Requires subject cooperation**

Iris images are:

- Segmented
- Encoded

Twins have different iris patterns.

Examples of Biometric Traits: Gait



Gait – the specific way one walks, complex spatio-temporal behavioral characteristic

Influenced by:

- Injuries involving joints or brain
- Aging

Gait features derived from a video sequence and consists of characterization of several movements.

Examples of Biometric Traits: Voice, hand geometry, ear, retina, infrared facial/hand vein thermograms, keystroke, DNA

Homework #1: Due (1/20/2011)

- Biometrics survey
- One page per biometric attribute (see p. 7 of slides)
- Identify recent research papers for each attribute

Comparison of Biometric Technologies[3]

Biometrics	Universality	Uniqueness	Permanence	Collectability	Performance	Acceptability	Circumvention
Face	High	LOW	Medium	High	LOW	High	LOW
Fingerprint	Medium	High	High	Medium	High	Medium	High
Hand Geometry	Medium	Medium	Medium	High	Medium	Medium	Medium
Keystrokes			LOW	Medium	LOW	Medium	Medium
Hand Vein	Medium	Medium	Medium	Medium	Medium	Medium	High
Iris	High	High	High	Medium	High	LOW	High
Retinal Scan	High	High	Medium	LOW	High	LOW	High
Signature	Low	Low	LOW	High	LOW	High	LOW
Voice Print	Medium	LOW	LOW	Medium	LOW	High	LOW
F. Thermograms	High	High	LOW	High	Medium	high	High
Odor	High	High	High	LOW	LOW	Medium	LOW
DNA	High	High	High	LOW	High	LOW	LOW
Gait	Medium	LOW	LOW	High	LOW	High	Medium
Ear	Medium	medium	High	medium	Medium	High	Medium

[3]A. K. Jain, R. Bolle, and S. Pankanti, editors. Biometrics: Personal Identification in Networked Society. Kluwer Academic Publishers, 1999.

Operation of a Biometric System

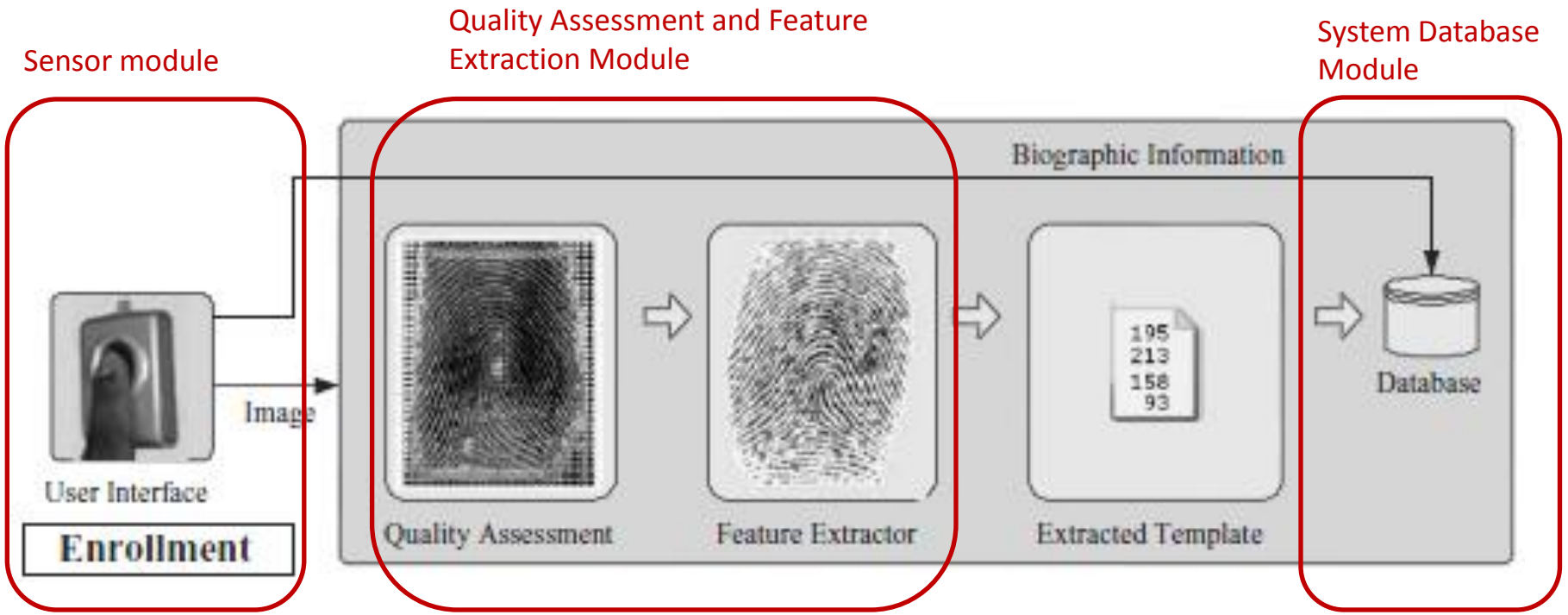
Biometric system – a pattern recognition system that:

- acquires biometric data from an individual
- extracts a salient feature set from the data
- compares the feature set against feature set(s) stored in the database
- executes an action based on the result of the comparison

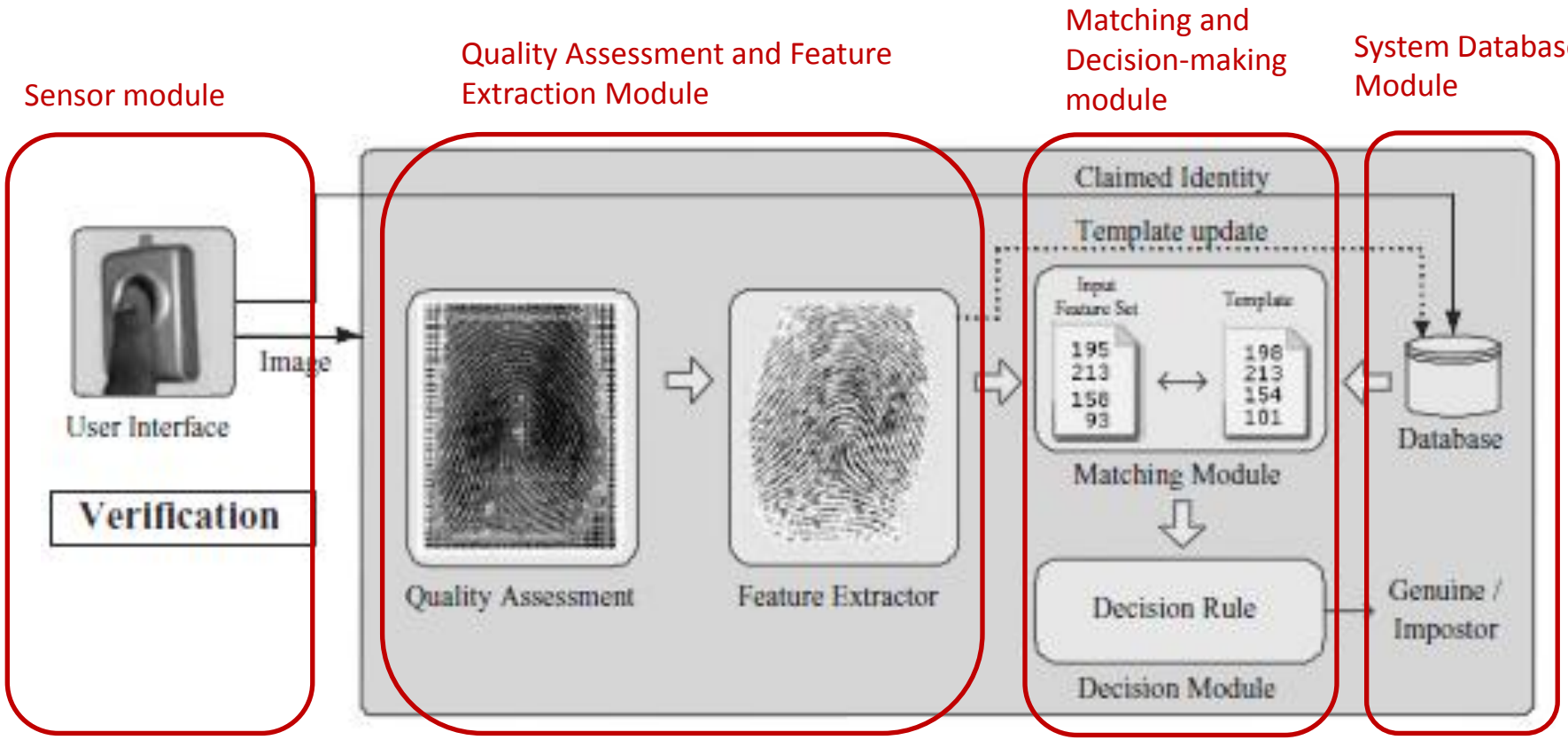
Therefore, it is composes of four main modules:

- Sensor module
- Quality assessment and feature extraction module
- Matching and decision making module
- System database module

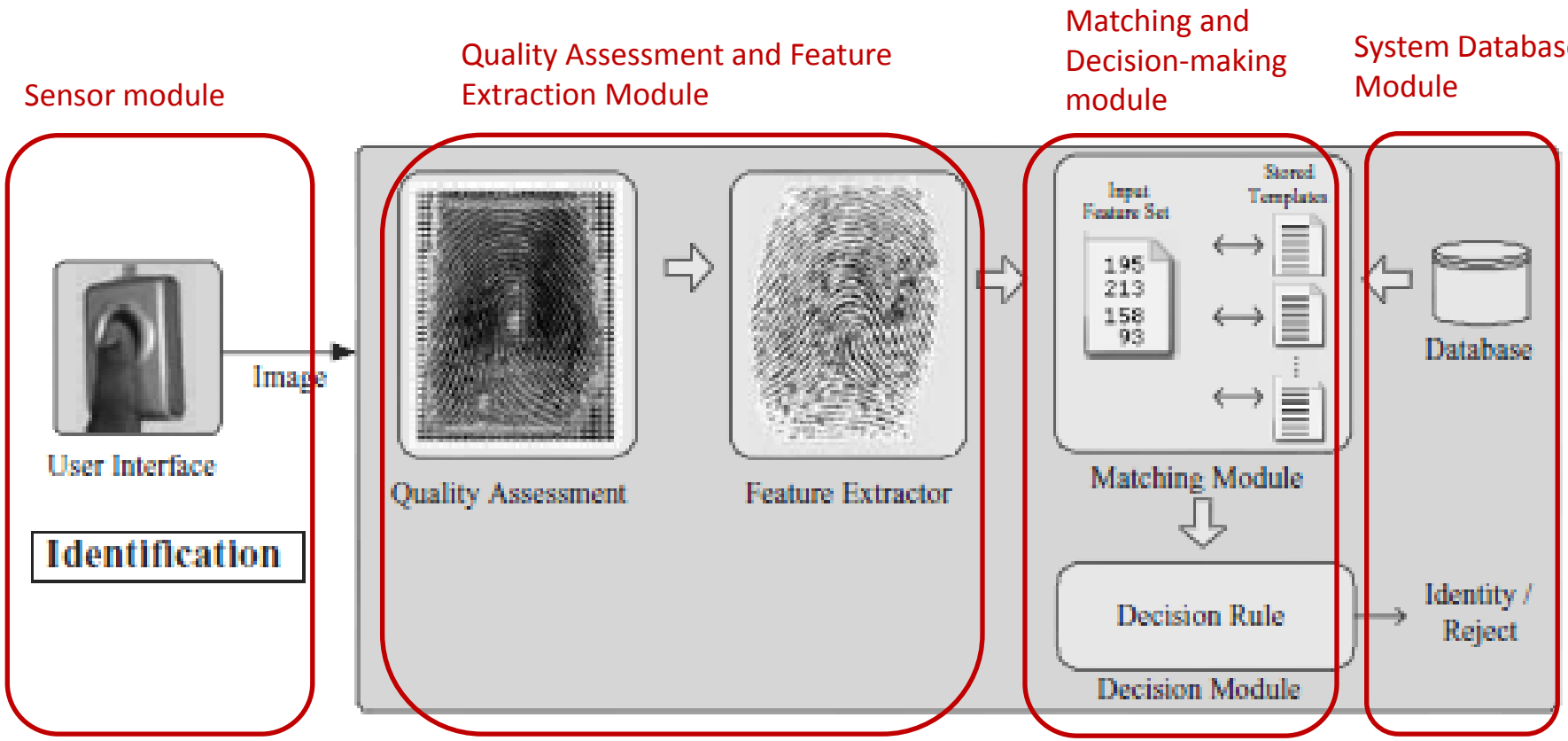
Operation of a Biometric System: Enrollment



Operation of a Biometric System: Verification



Operation of a Biometric System: Identification



Conclusion

- Introduction
- Biometrics Definition
- Biometric Characteristics
- Examples of Biometric Traits: Fingerprints, Face, Iris, Gait
- Comparison of Biometric Technologies
- Operation of a Biometric System: Enrollment, Verification, Identification

Next Topic

Introduction to Statistical Pattern Recognition

Anil K. Jain, Robert P. W. Duin, Jianchang Mao, “Statistical Pattern Recognition: A Review,” IEEE Transactions on PAMI, Vol. 22, No. 1. (January 2000), pp. 4-37

References

Jain, Anil K.; Flynn, Patrick; Ross, Arun A. (Eds.), “Handbook of Biometrics,” Springer, 1 ed. (August 31, 2007)

A. K. Jain, R. Bolle, and S. Pankanti, editors. Biometrics: Personal Identification in Networked Society. Kluwer Academic Publishers, 1999.

Natalia A. Schmid, BIOM 426 (Introduction to Biometrics Systems) Course Website, http://www.csee.wvu.edu/~natalias/biom426/biom426_fall05.html