Other Traits

COMP 388-002/488-002 Biometrics

Daniel Moreira

Fall 2024

Today we will...

Get to know
Alternative traits and
soft biometrics.

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Today's Attendance

Please fill out the form
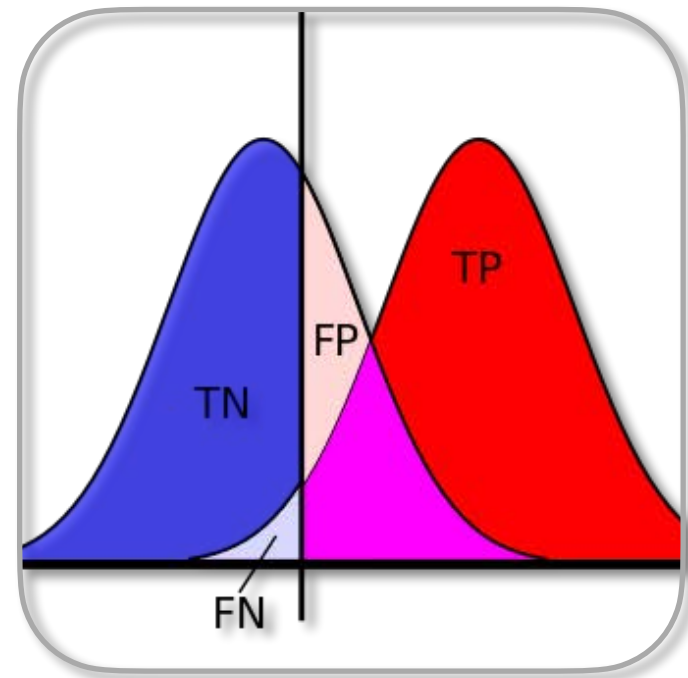
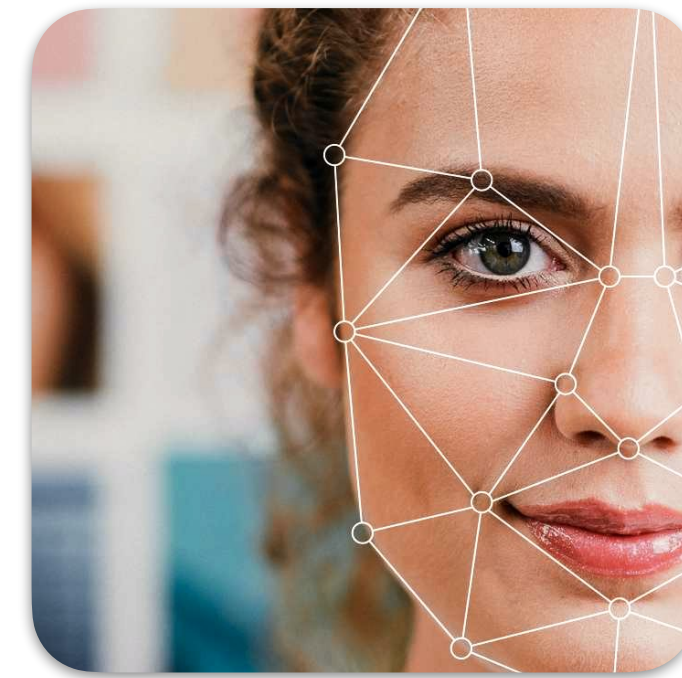https://forms.gle/Ddu6RBRB7TUkkNK37
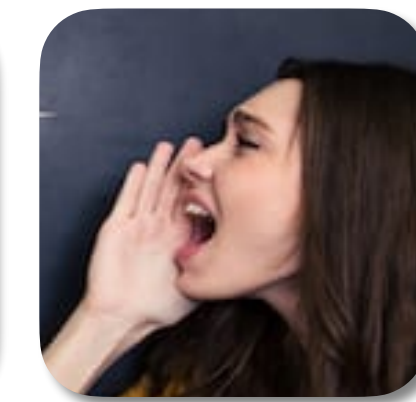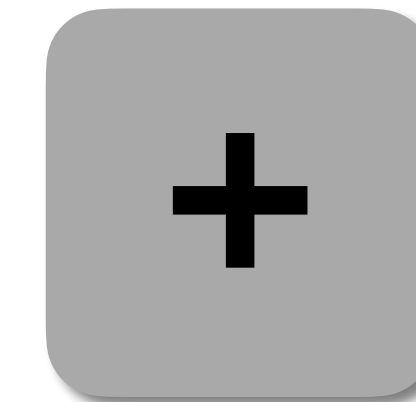
Course Overview

Content

Basics
Concepts
Metrics
Metric
implementation

Core Traits (3)
Concepts
Baseline implementation
Data collection
Evaluation
Attacks
Assignments

Alternative Traits and Fusion
Concepts

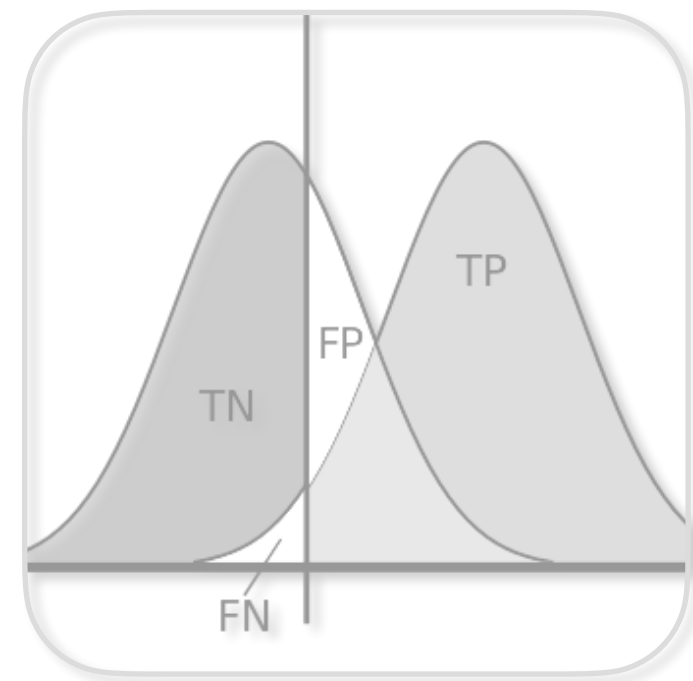**Invited Talks** (2)
State of the art
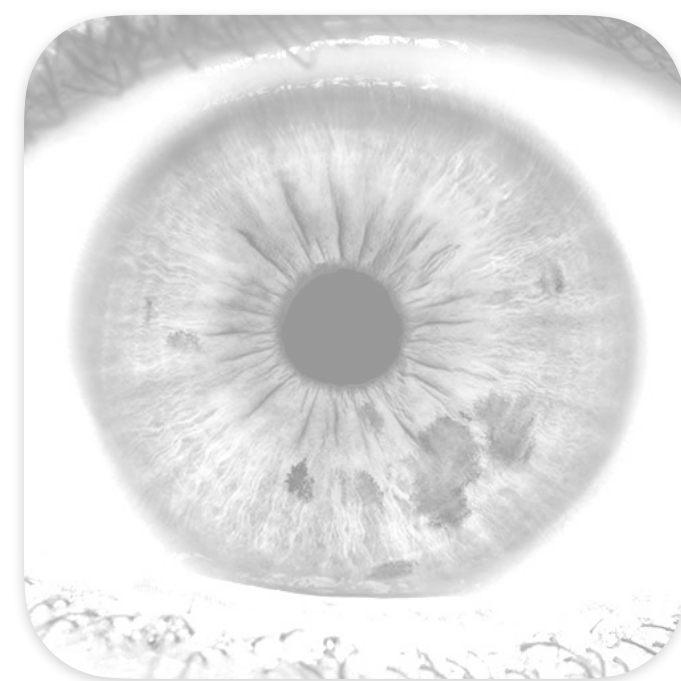Future work
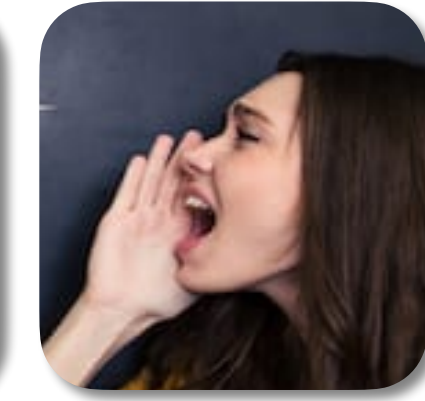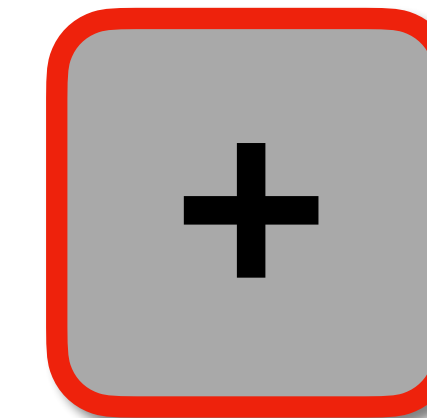
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Course Overview

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Concepts
Metrics
Metric
implementation

Core Traits (3)
Concepts
Baseline implementation
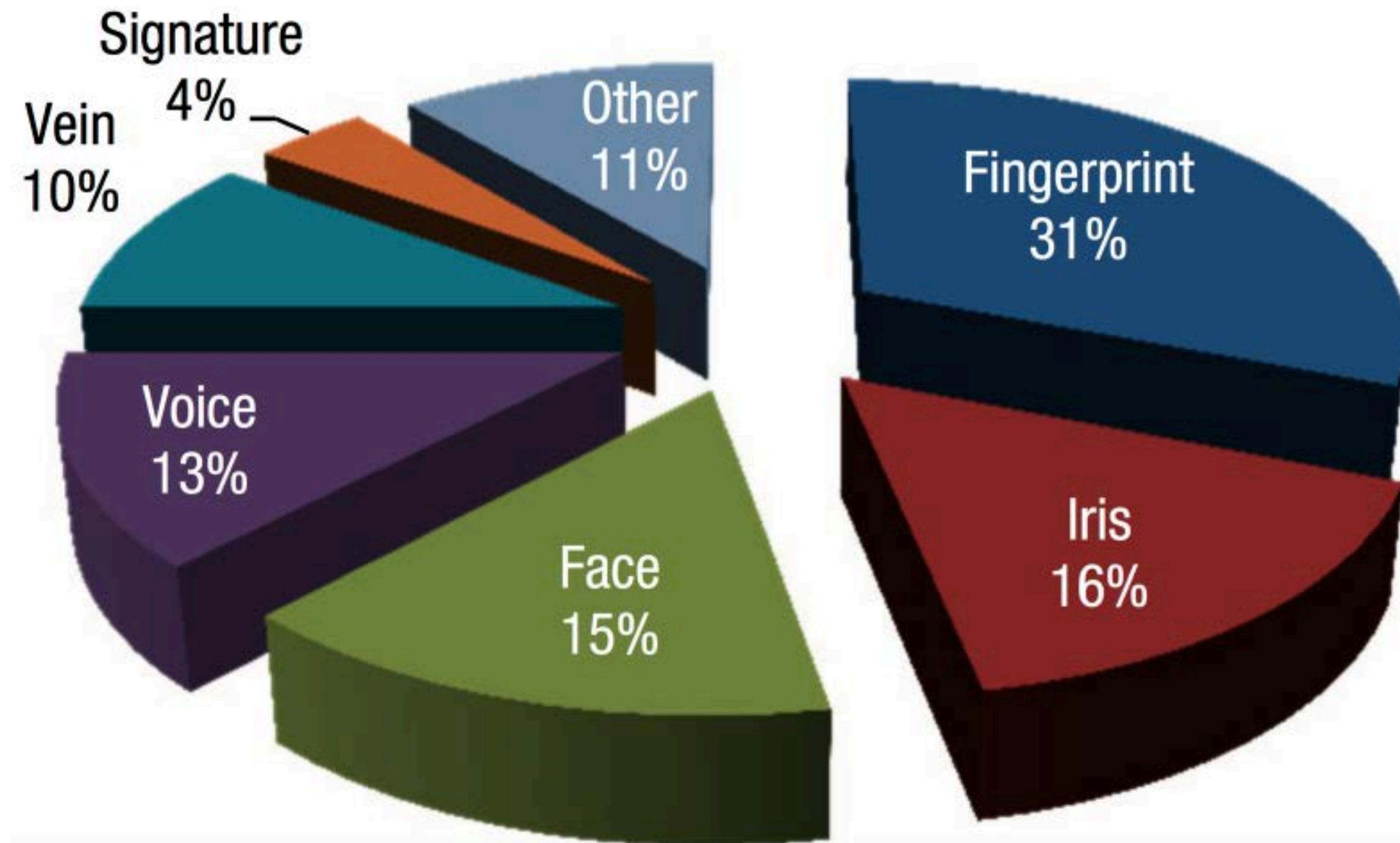Data collection
Evaluation
Attacks
Assignments

Alternative Traits and Fusion
Concepts

Invited Talks (2)
State of the art
Future work

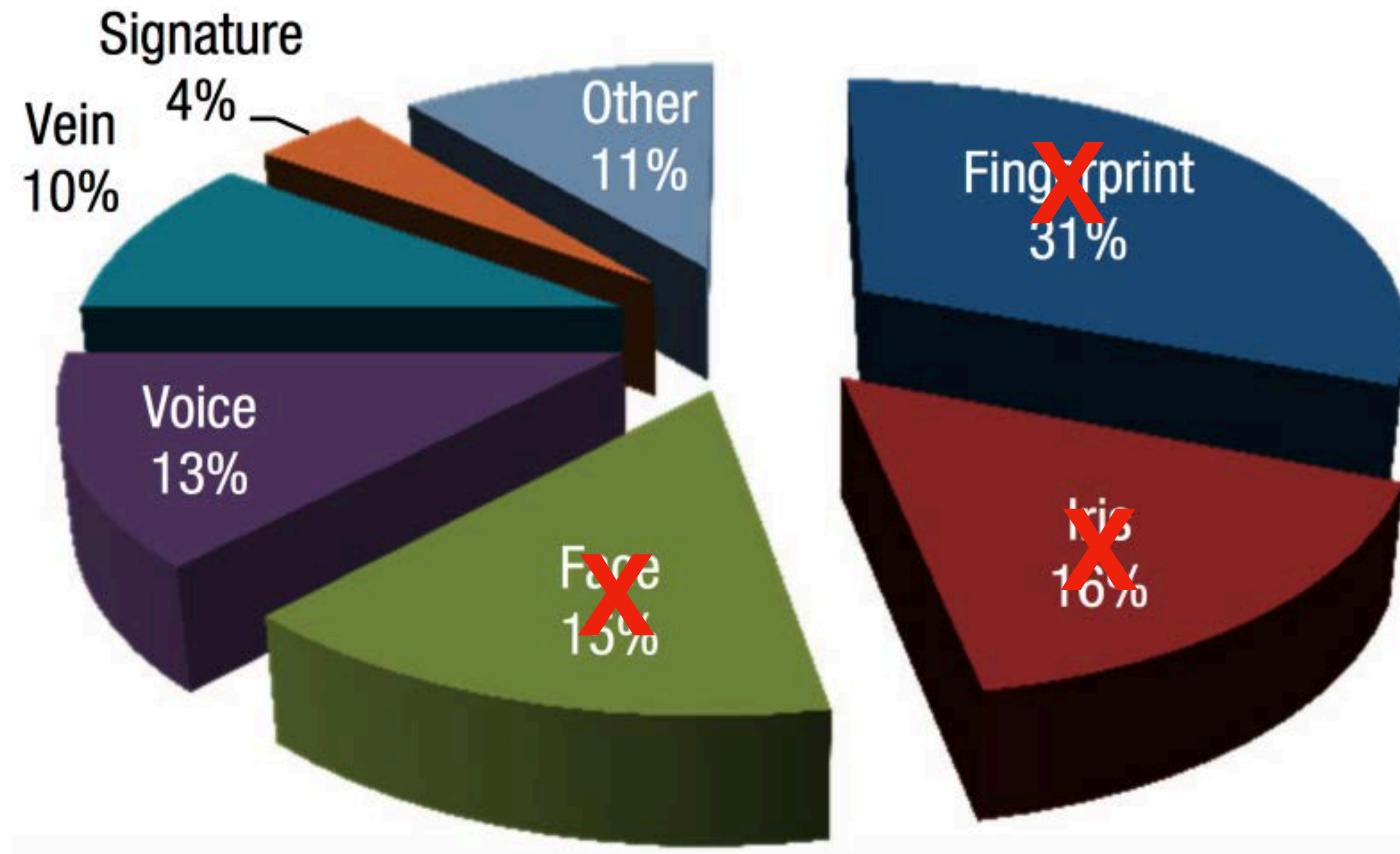# Alternative Traits

Market

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015
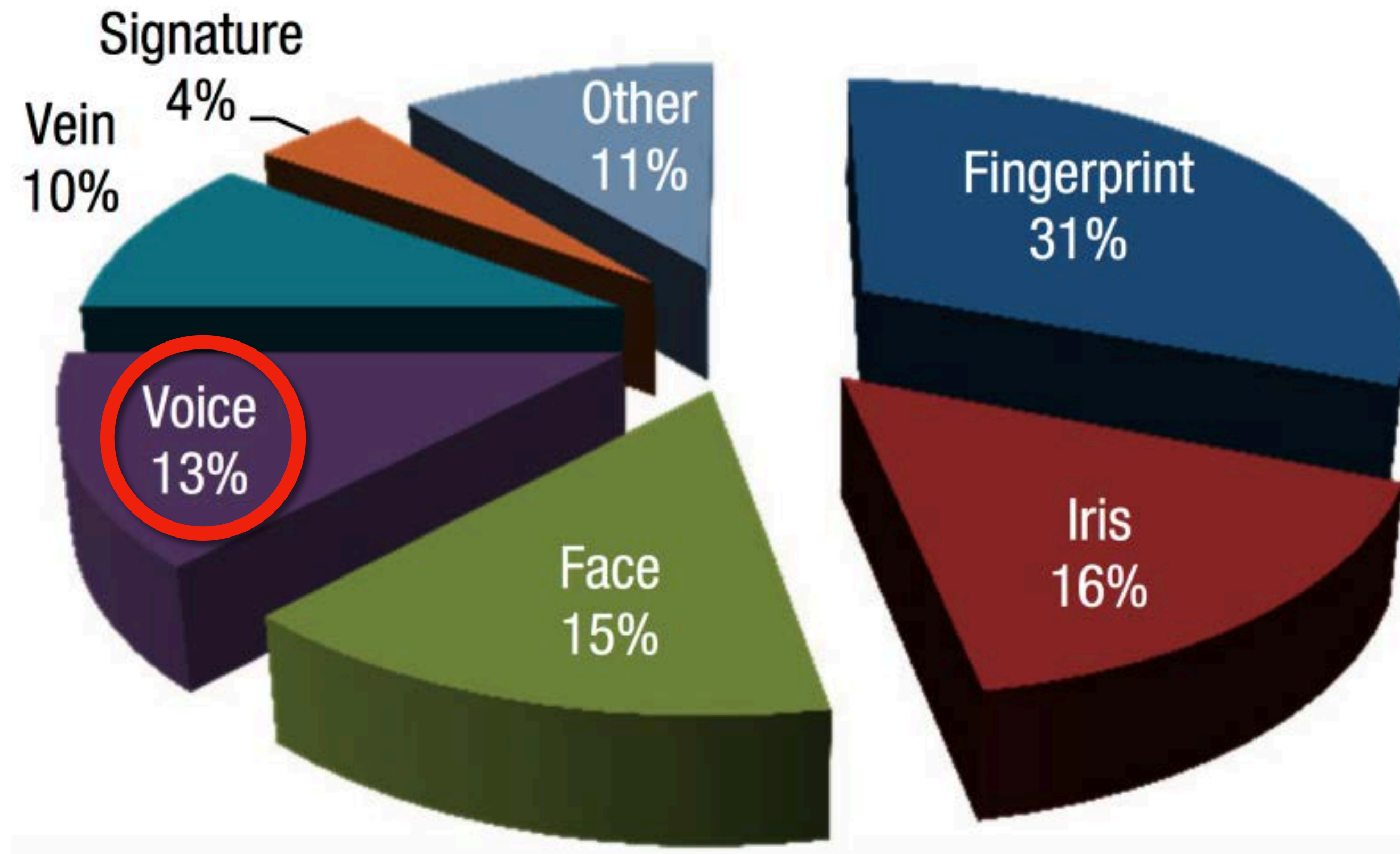
Alternative Traits

Market

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

Alternative Traits

Market

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015
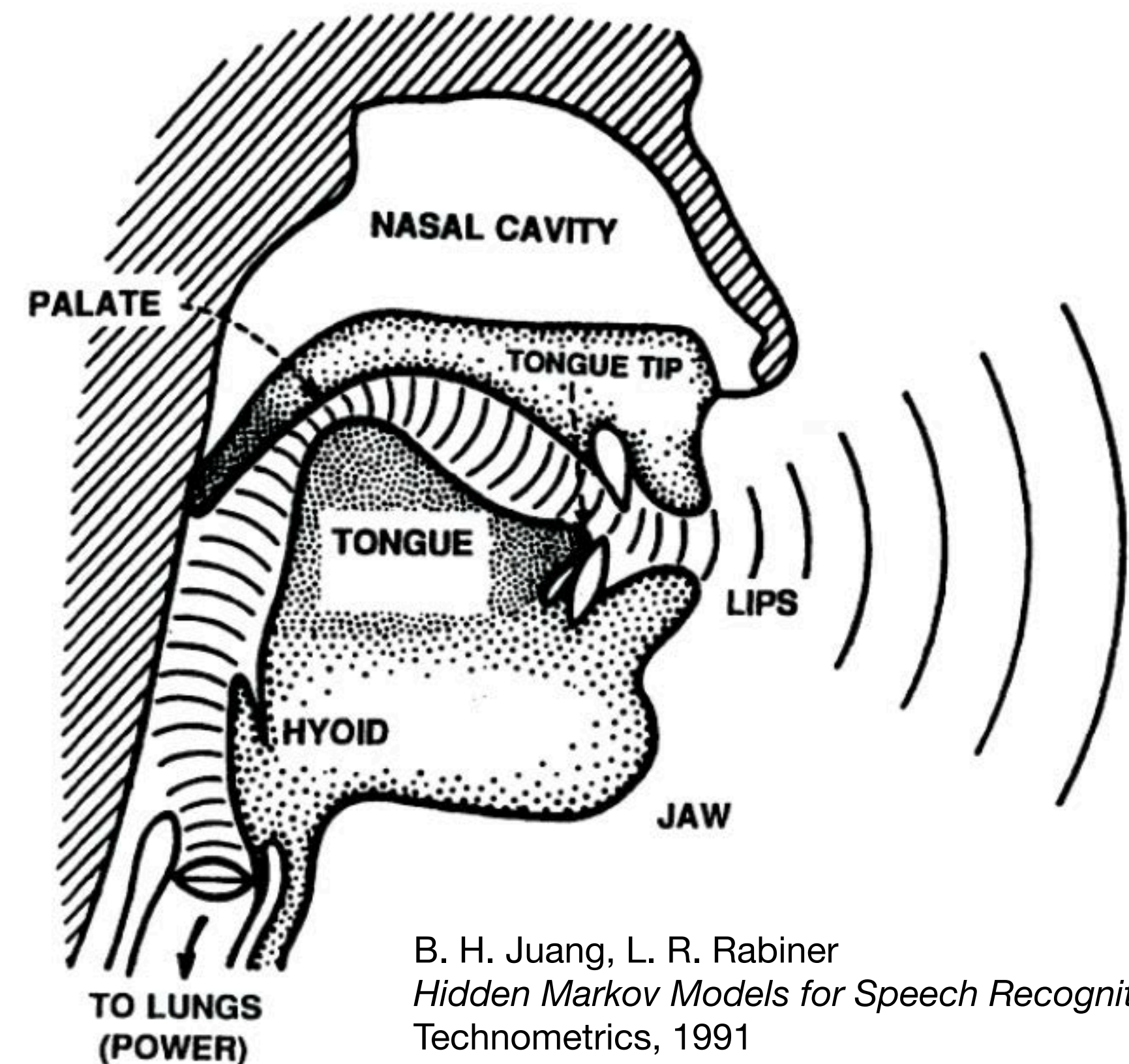
Voice Recognition

Human Vocal System

Complex combination of organs,
rooted on *genetic* factors
but mostly *epigenetic*.

Health, age, mood, stress,
and even mother tongue
will influence somebody's voice.

B. H. Juang, L. R. Rabiner
Hidden Markov Models for Speech Recognition
Technometrics, 1991

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Voice Recognition
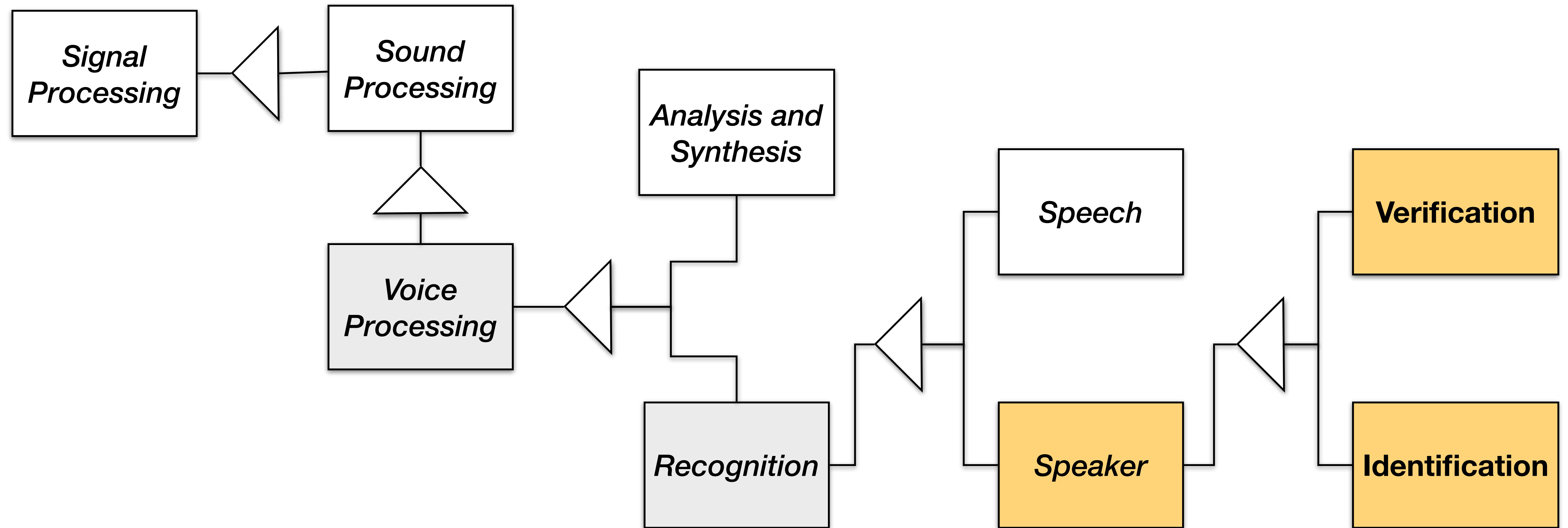
Acquisition

Off-line

On-line

Voice Recognition

Field Development

Voice Recognition

Variants

Fixed-Text
Enrollment and authentication
with the same word.

Text-Dependent
Usage of authentication phrases
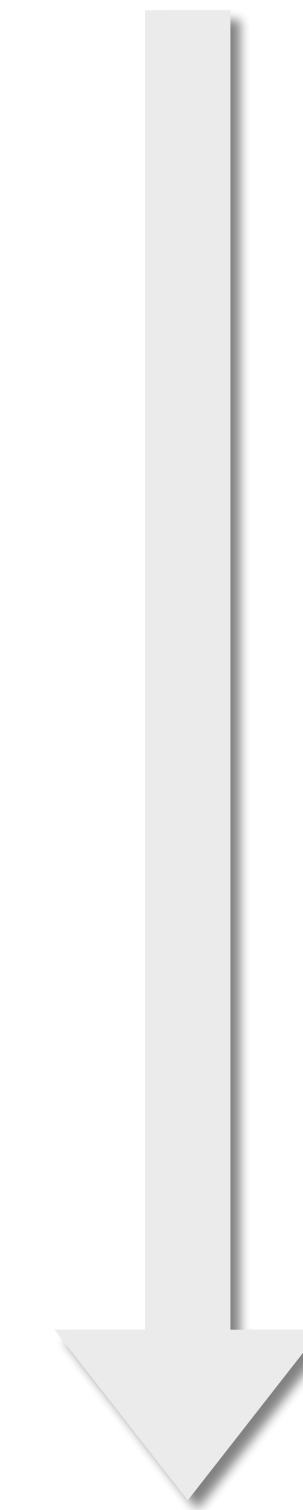(composed from a pre-defined vocabulary).

Text-Independent
Users may say any word/phrase.

Conversational (under development)
Speech and speaker recognition,
with semantic analysis.

Security

increases

12

Voice Recognition

A New Era of Presentation Attack
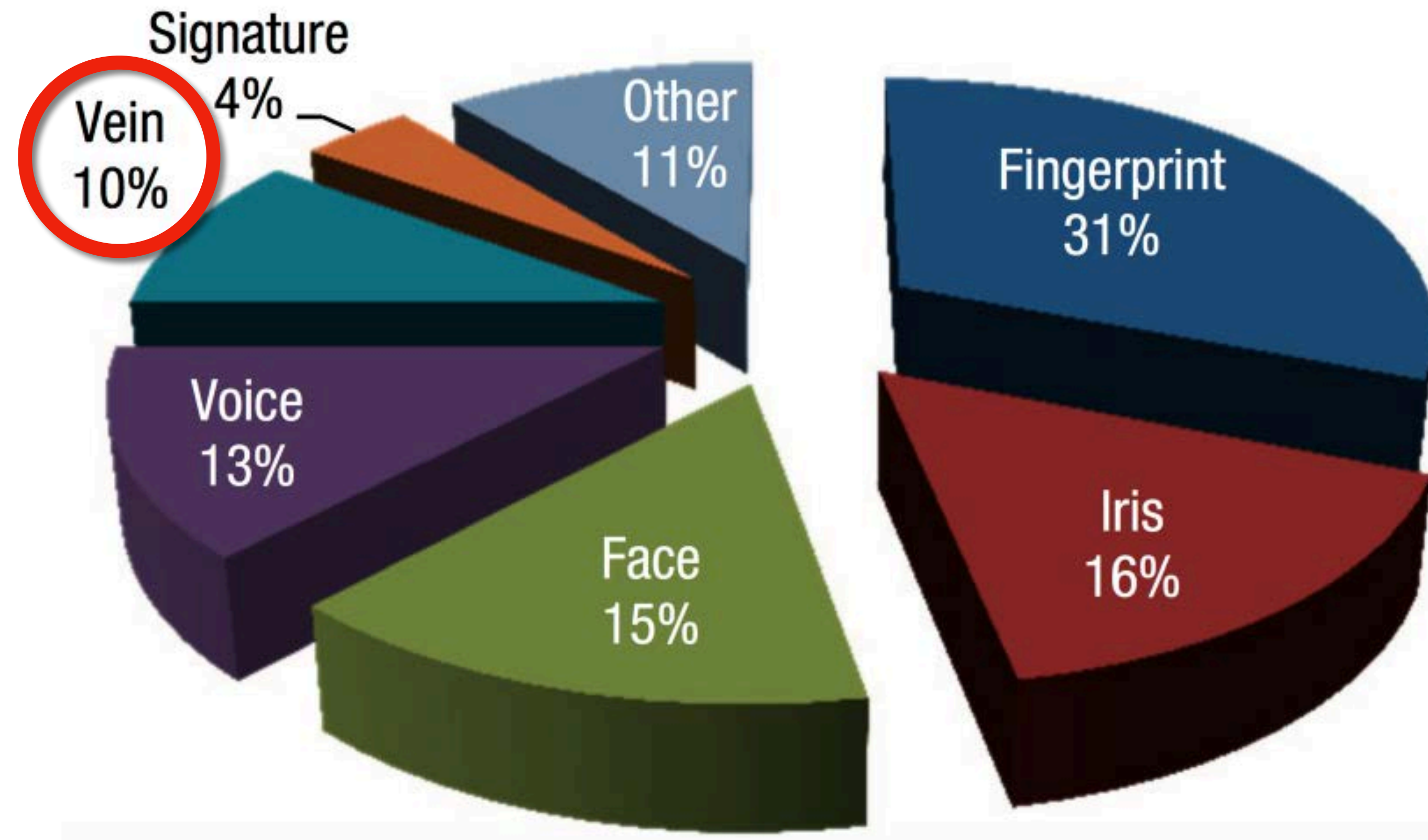
The following audio clips are not real, they were generated by a machine learning model.

https://www.youtube.com/watch?v=DWK_iYBl8cA

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Alternative Traits

Market

Signature 4%
Vein 10%
Other 11%
Fingerprint 31%
Voice 13%
Face 15%
Iris 16%

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

Vein Recognition

Human Circulatory System

Veins are *epigenetic*.

Commonest modalities:
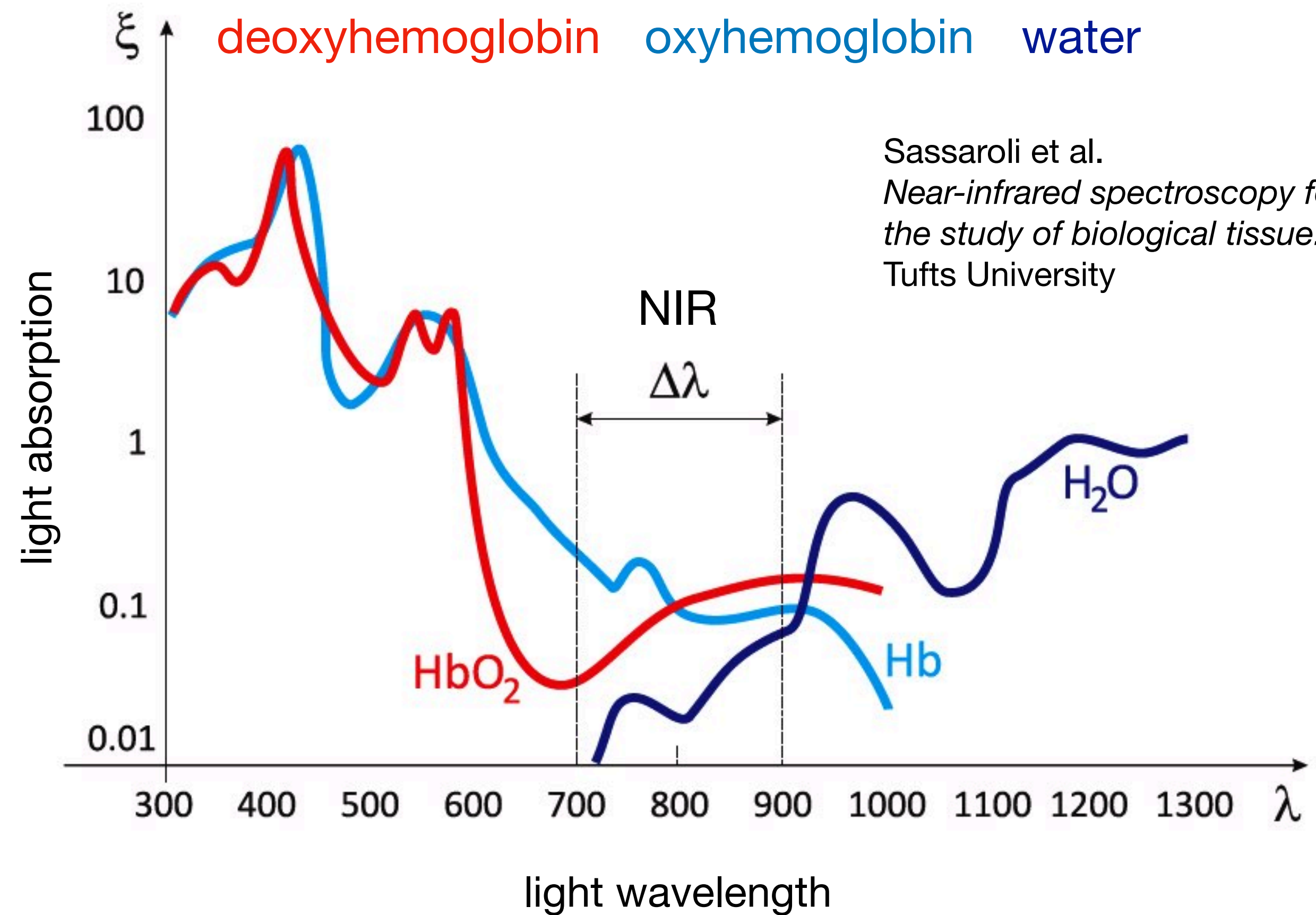palm and finger veins.

Dr. Adam Czajka

Hitachi
Finger Vein Authentication
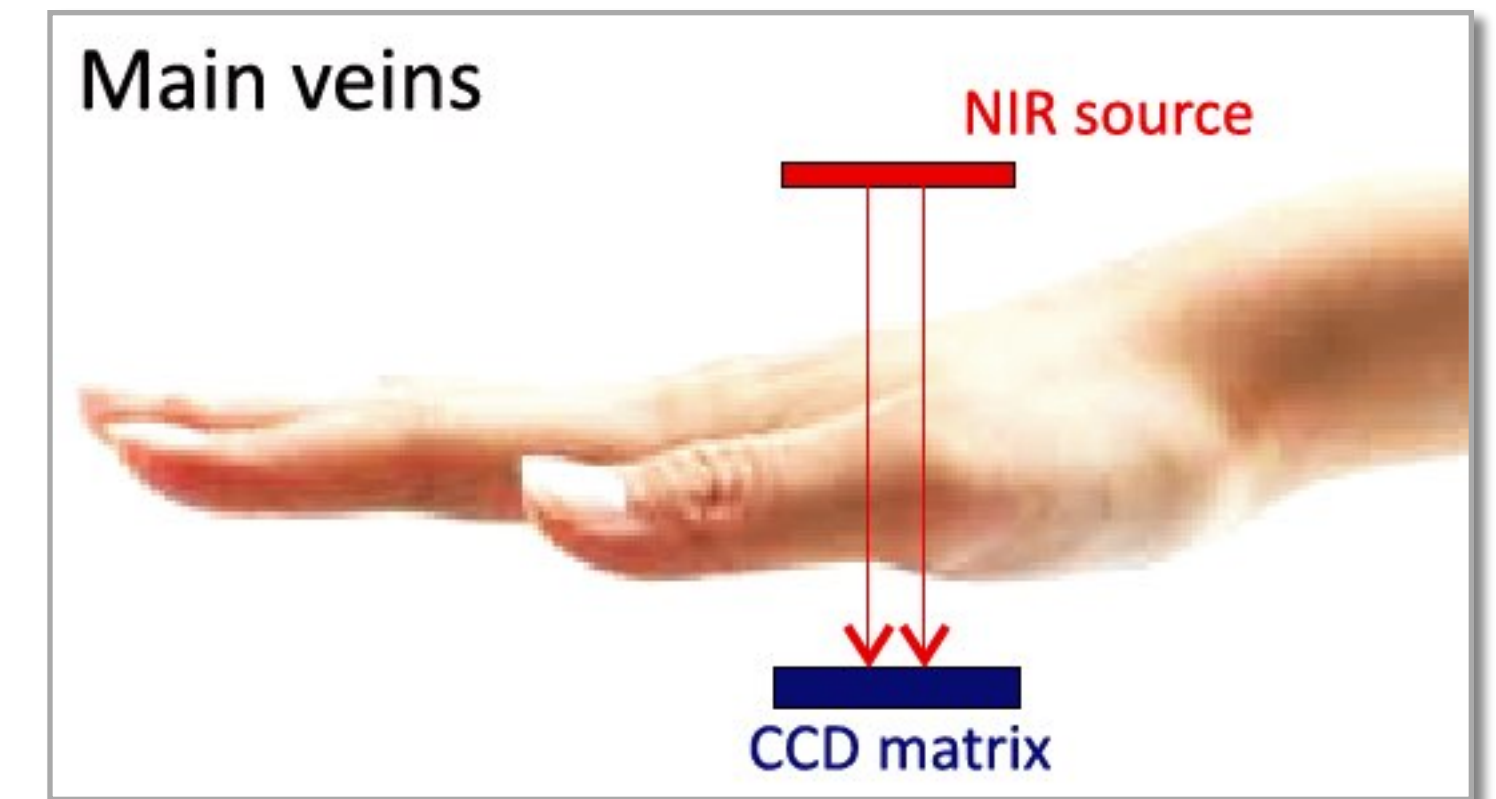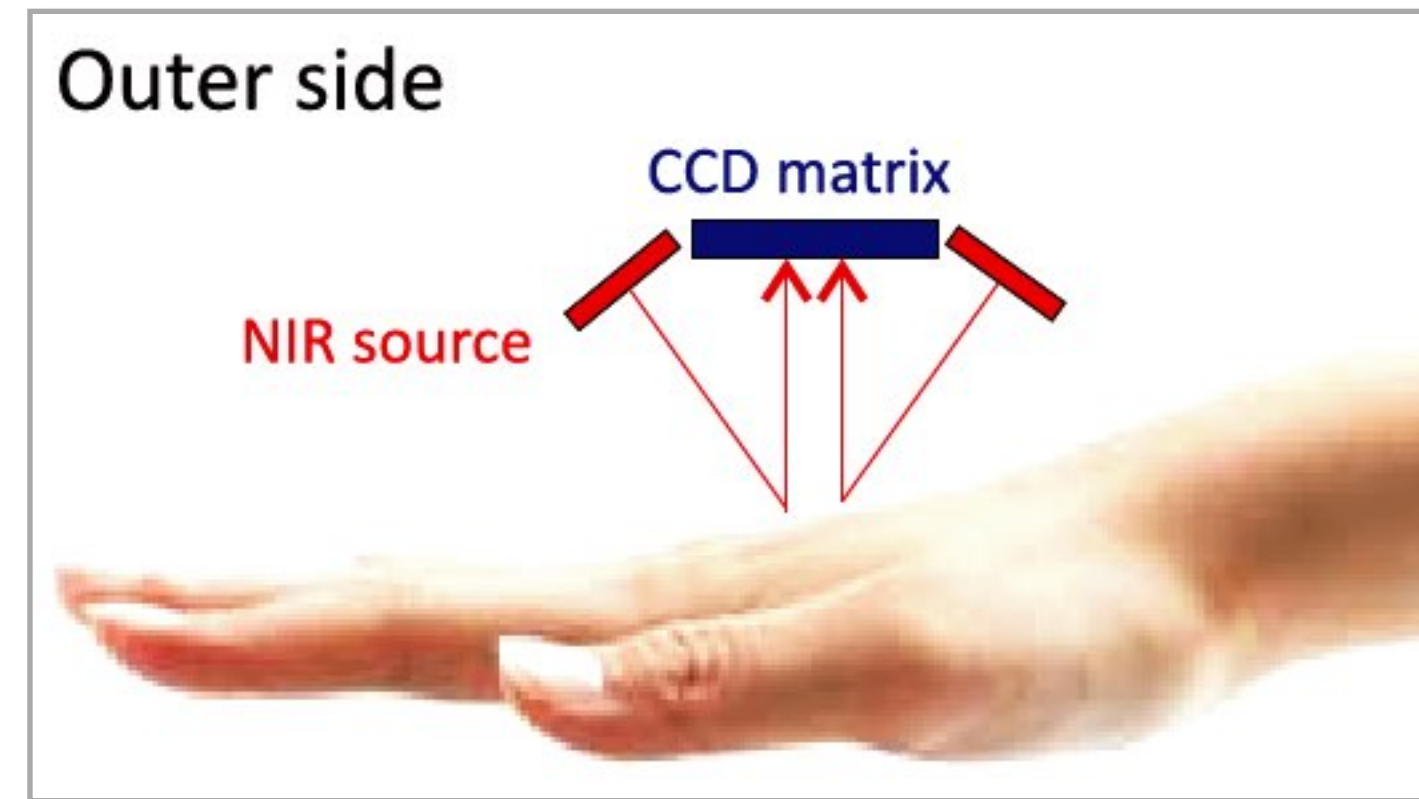White Paper, 2004

Vein Recognition

Acquisition

Dedicated near-infrared (NIR)
light sensors
(on-line acquisition).

deoxyhemoglobin   oxyhemoglobin   water

Sassaroli et al.
*Near-infrared spectroscopy for
the study of biological tissue.*
Tufts University

NIR

$\Delta\lambda$

ξ

light absorption

HbO_2

H_2O

Hb

light wavelength

Vein Recognition

Palm Vein Acquisition
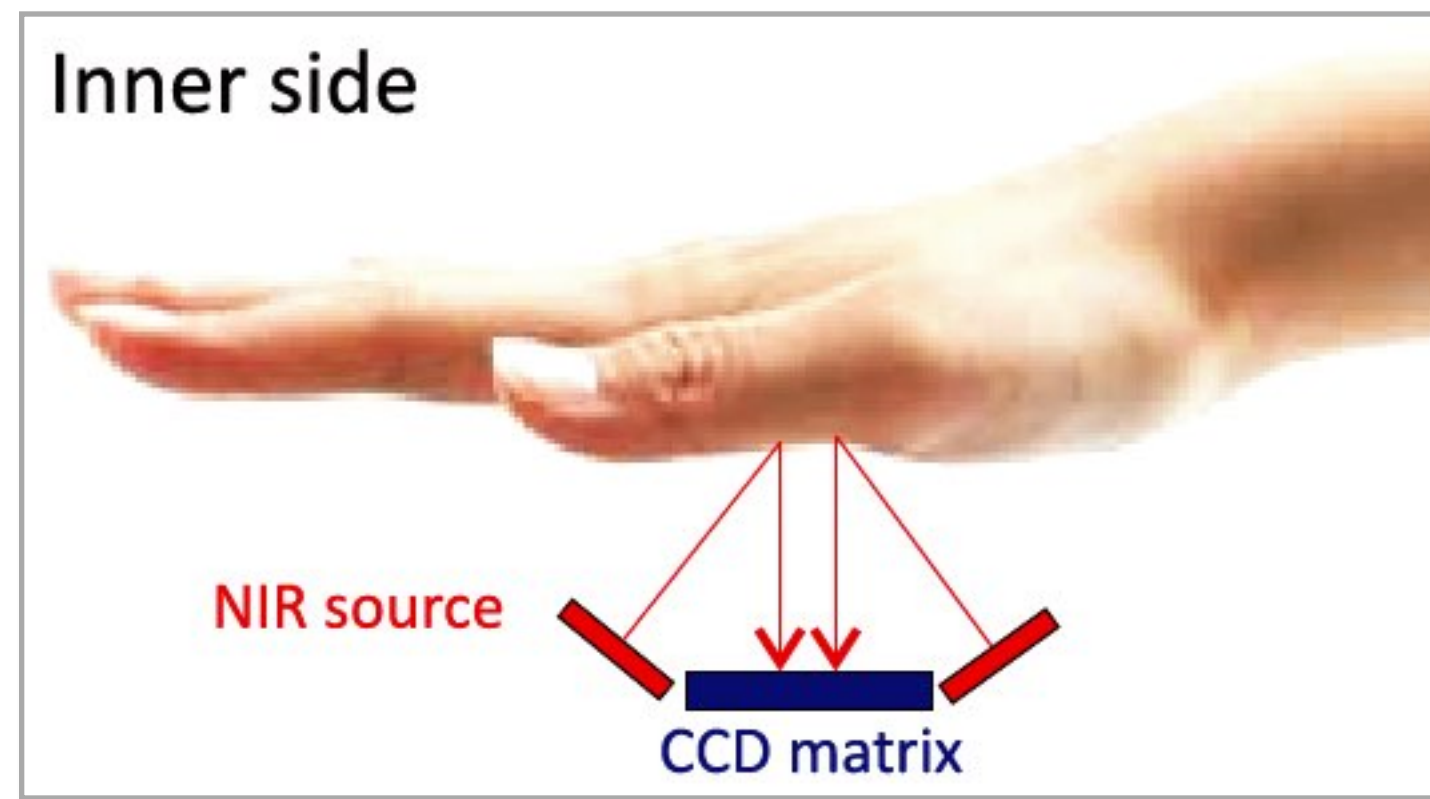
Dr. Adam Czajka

Vein Recognition

Palm Vein Acquisition

MITRE
State of the Art Biometrics Excellence Roadmap
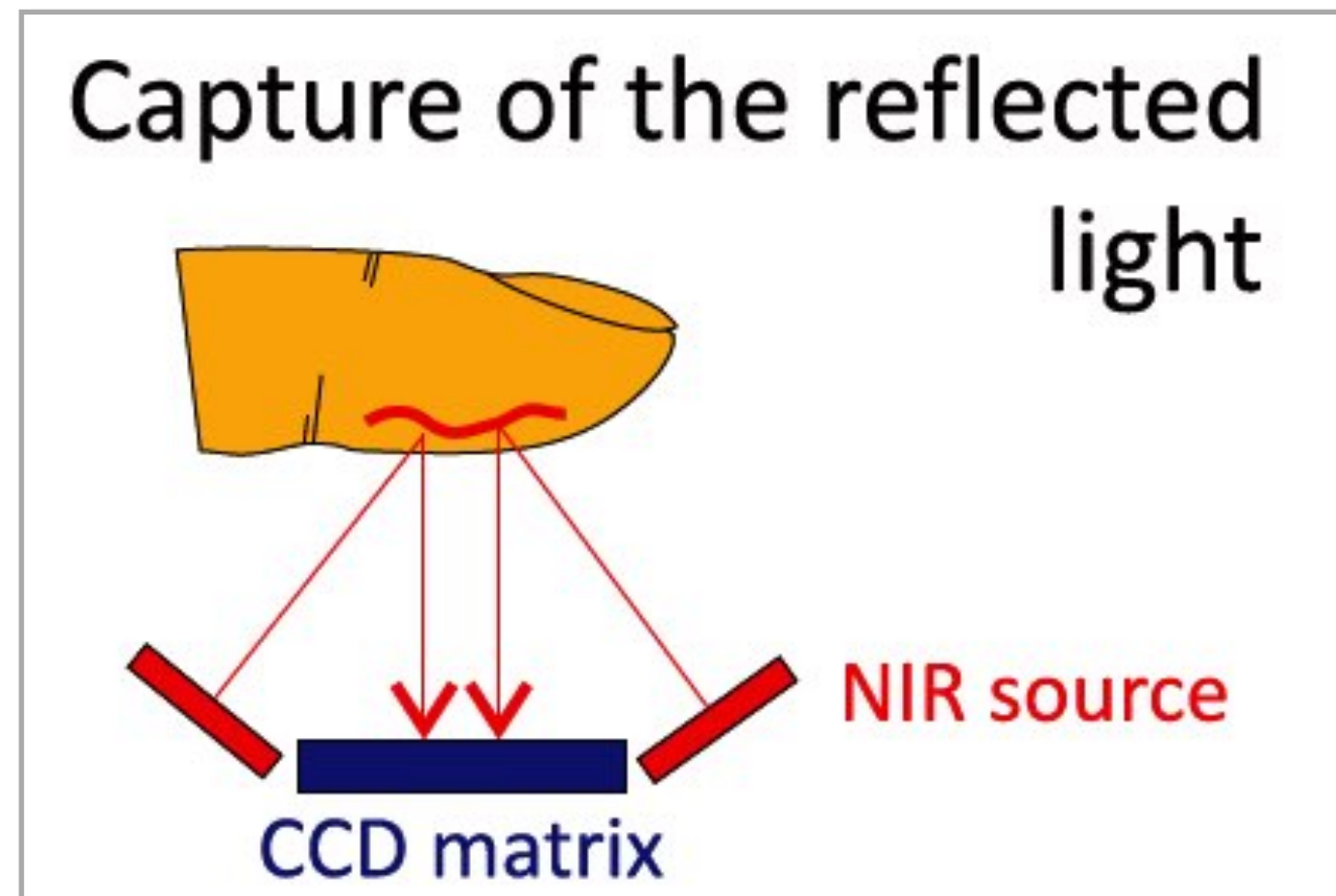Tech. Report, 2008

Fujitsu PalmSecure reader

Techsphere VP II reader
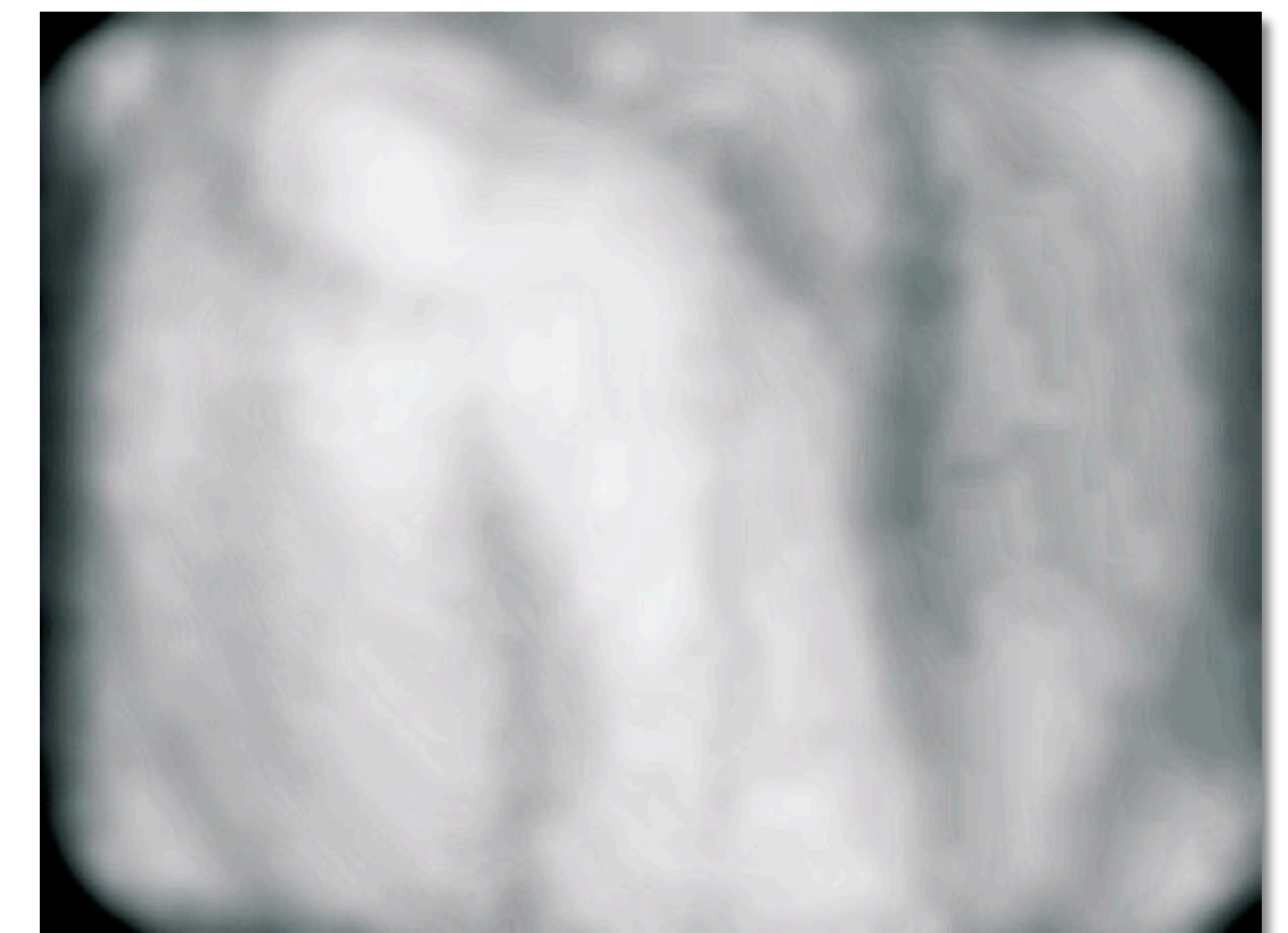
Vein Recognition
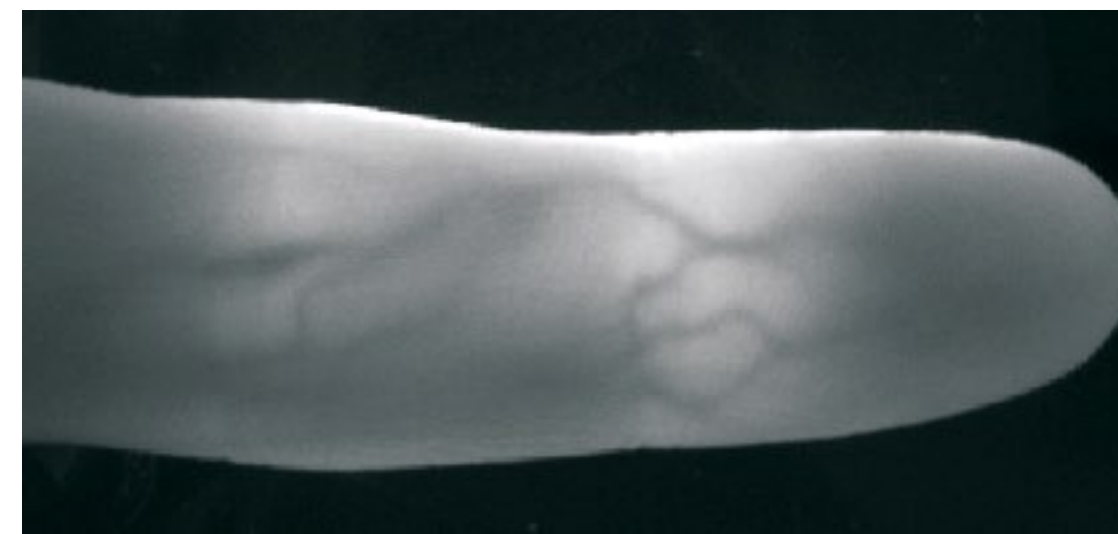
Finger Vein Acquisition
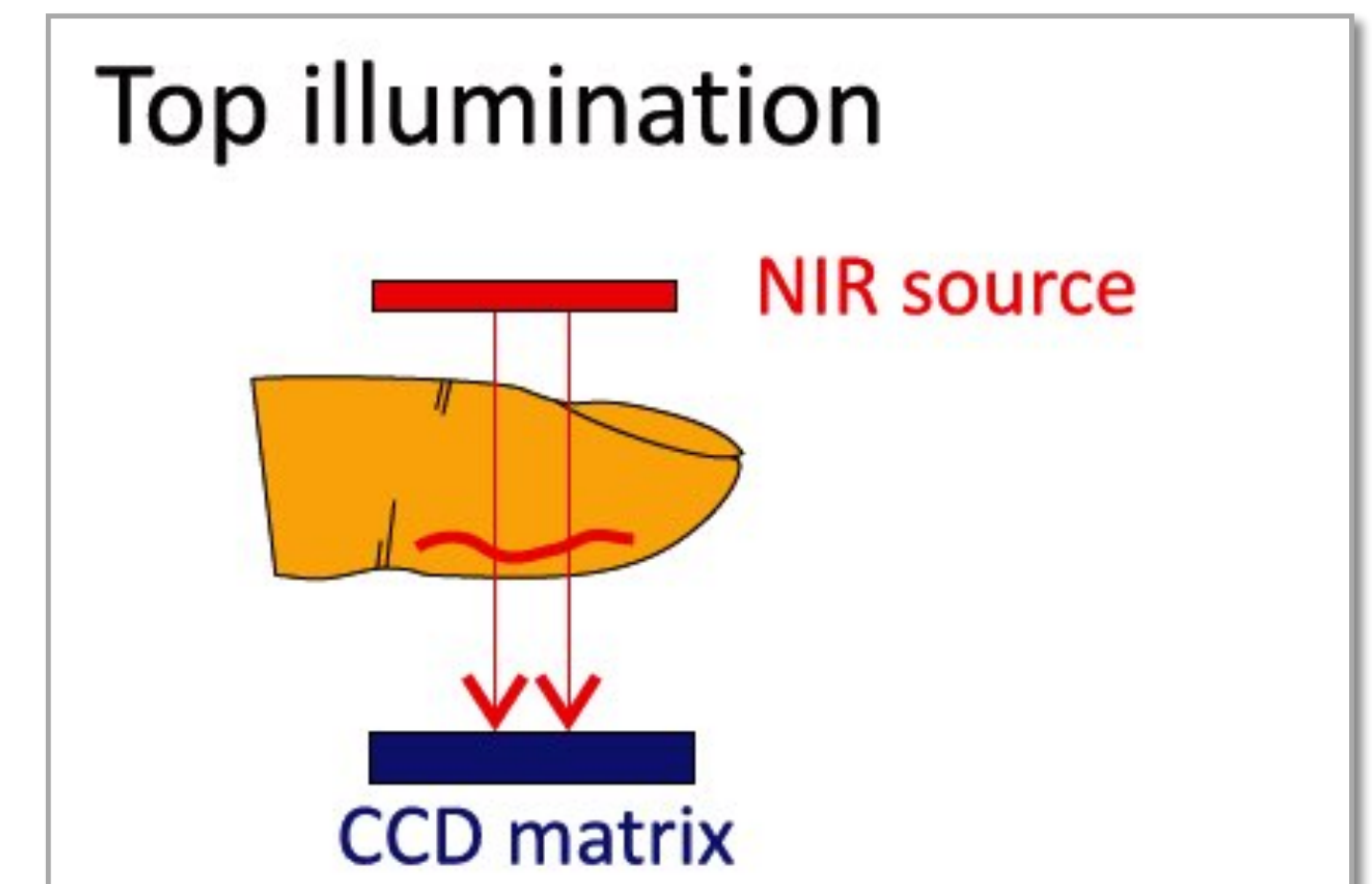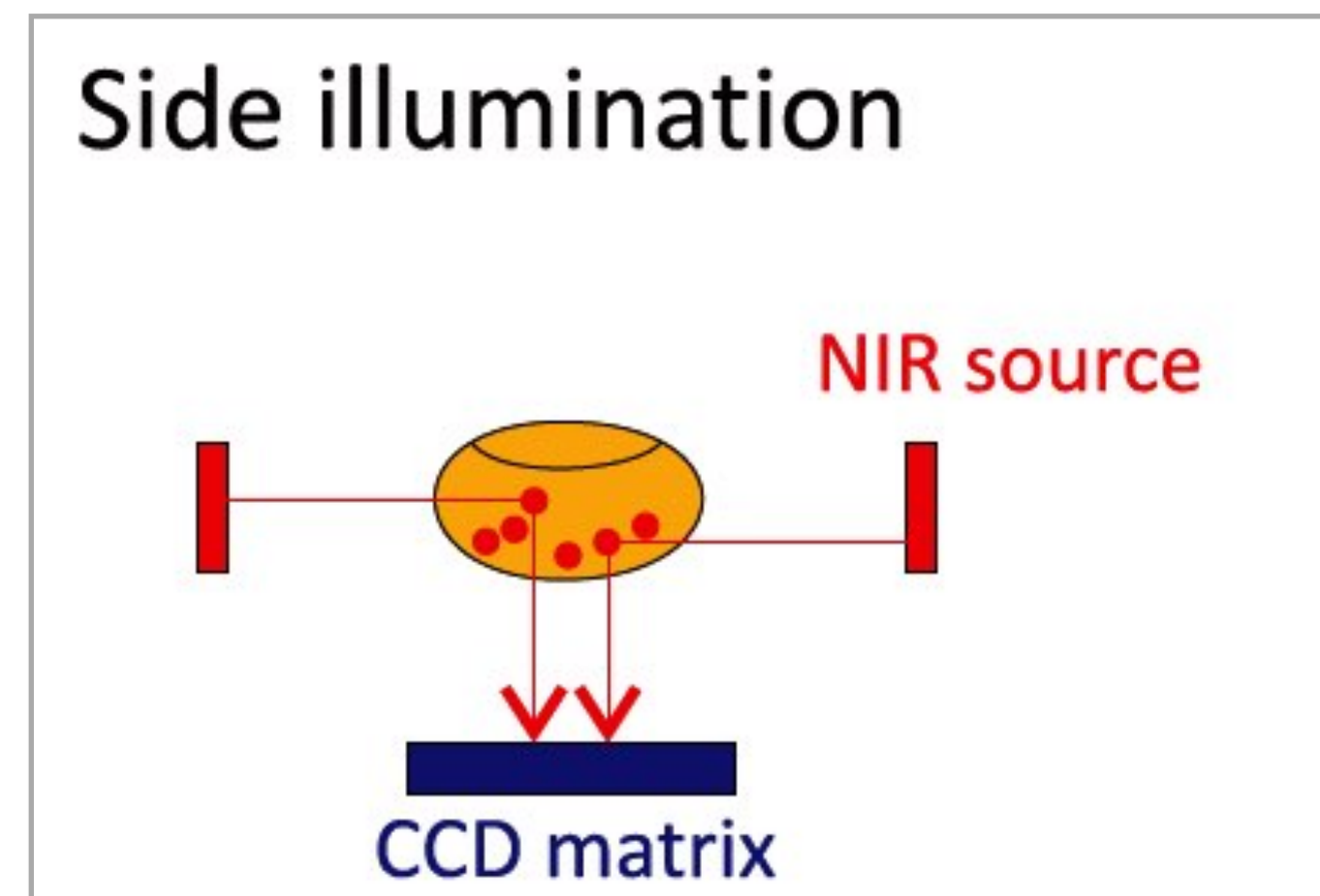
Dr. Adam Czajka

Vein Recognition

Finger Vein Acquisition

Hitachi H1 reader
(with top illumination)

MITRE
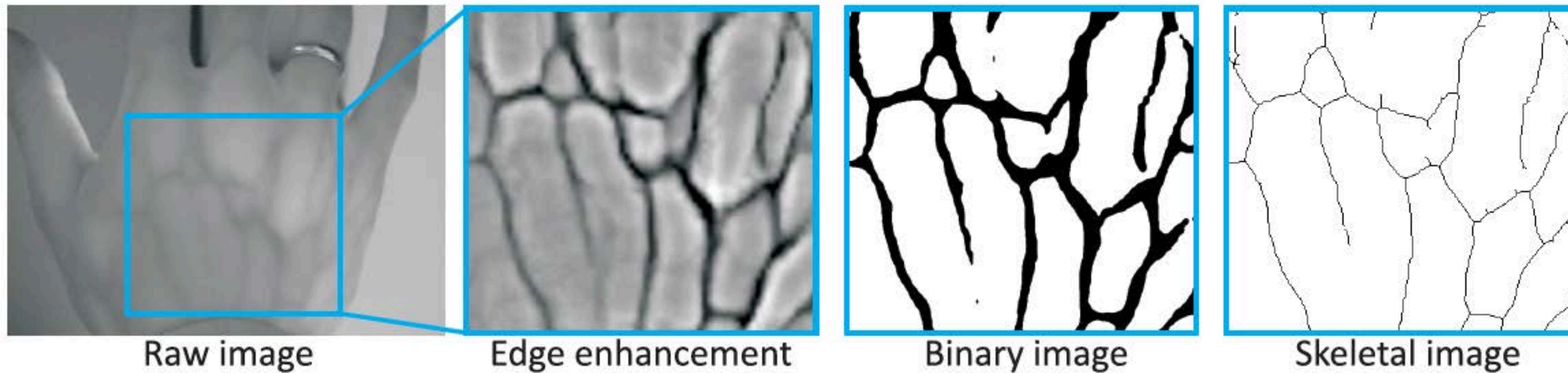*State of the Art Biometrics Excellence Roadmap*
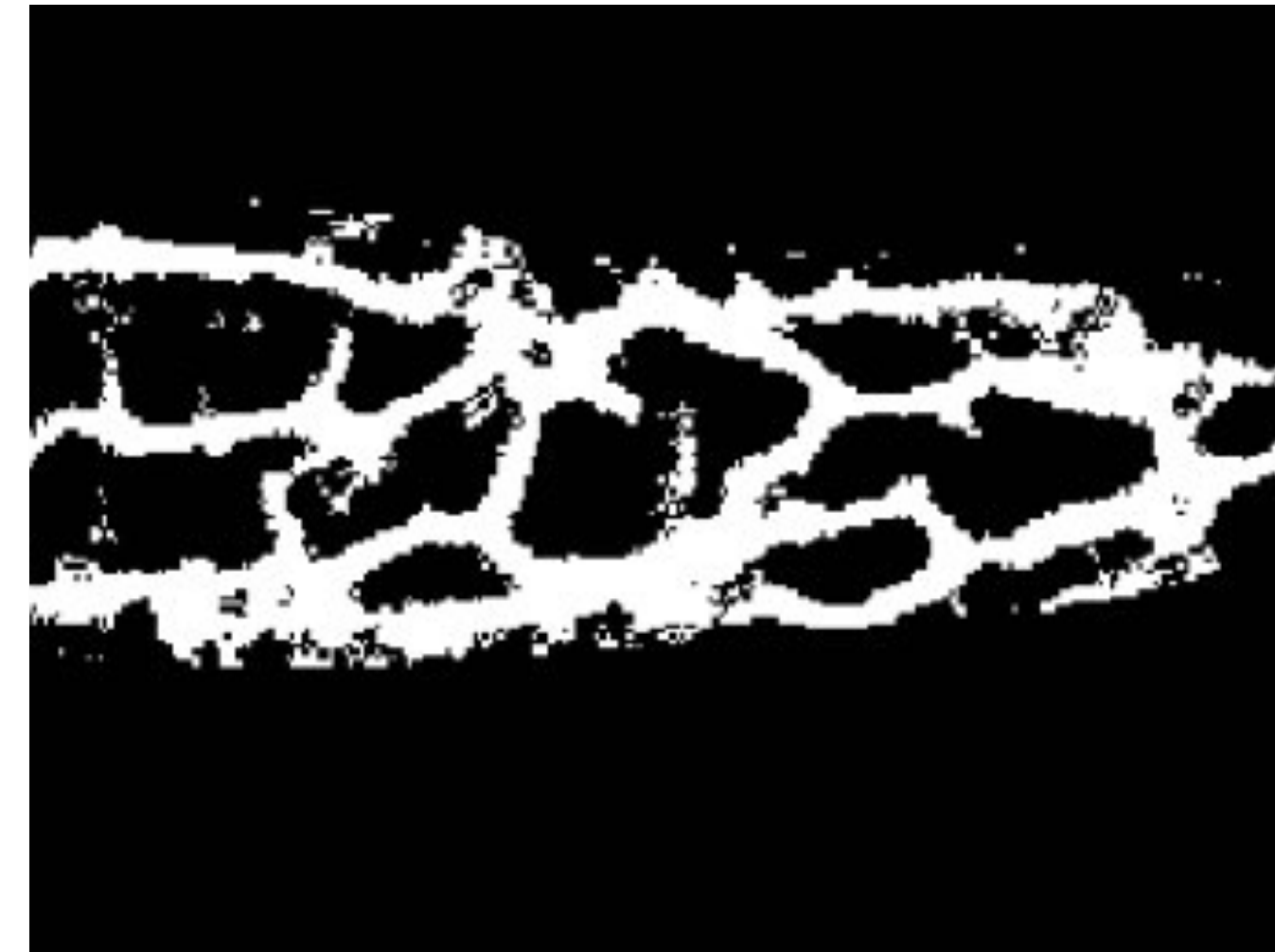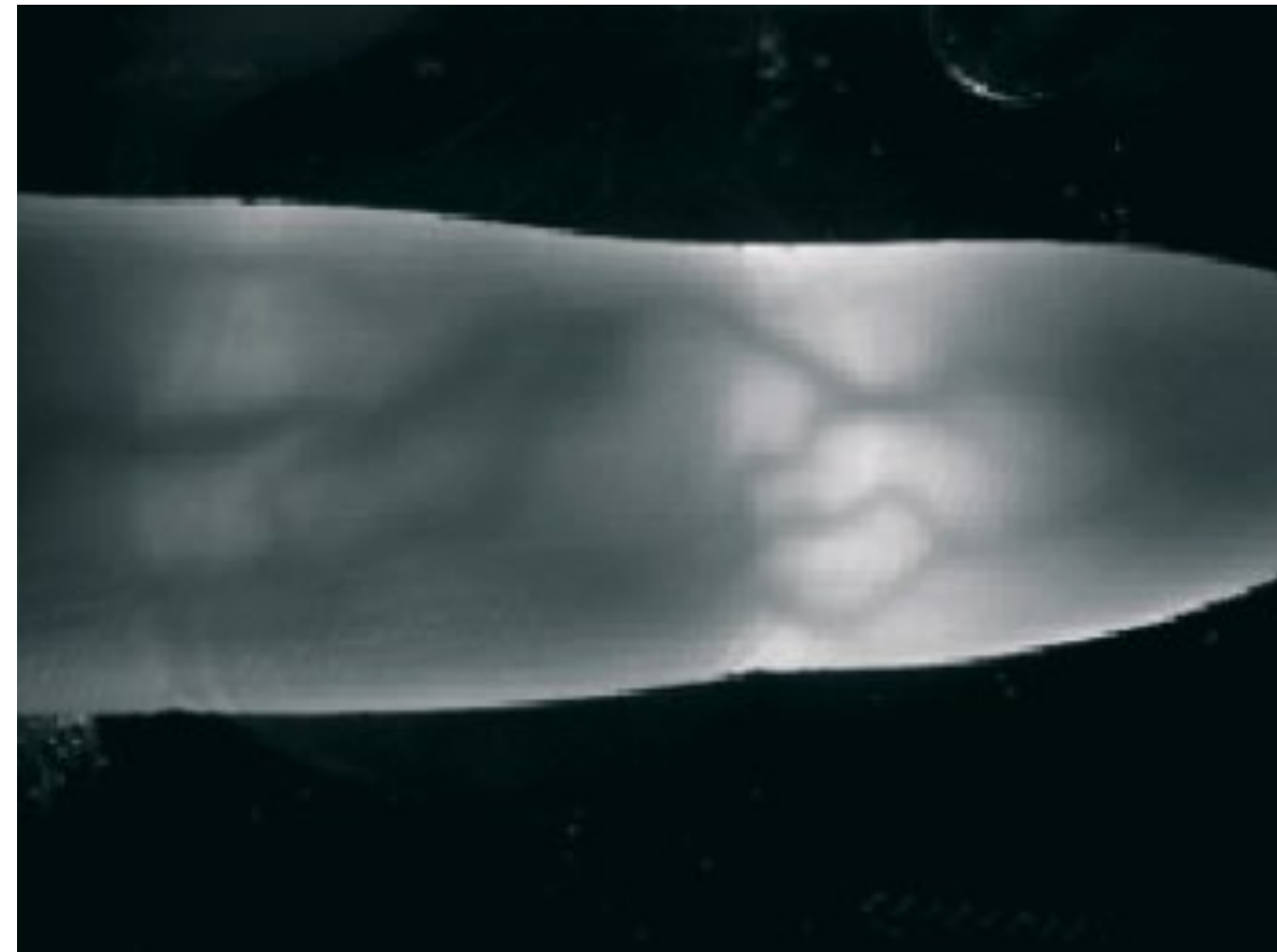Tech. Report, 2008

Vein Recognition

Vein Description Strategies

Dr. Adam Czajka

Raw image   Edge enhancement   Binary image   Skeletal image

Vein Recognition

Vein Description Strategies

Miura et al.
Extraction of Ginger-Vein Patterns Using Maximum Curvature Points in Image Profiles
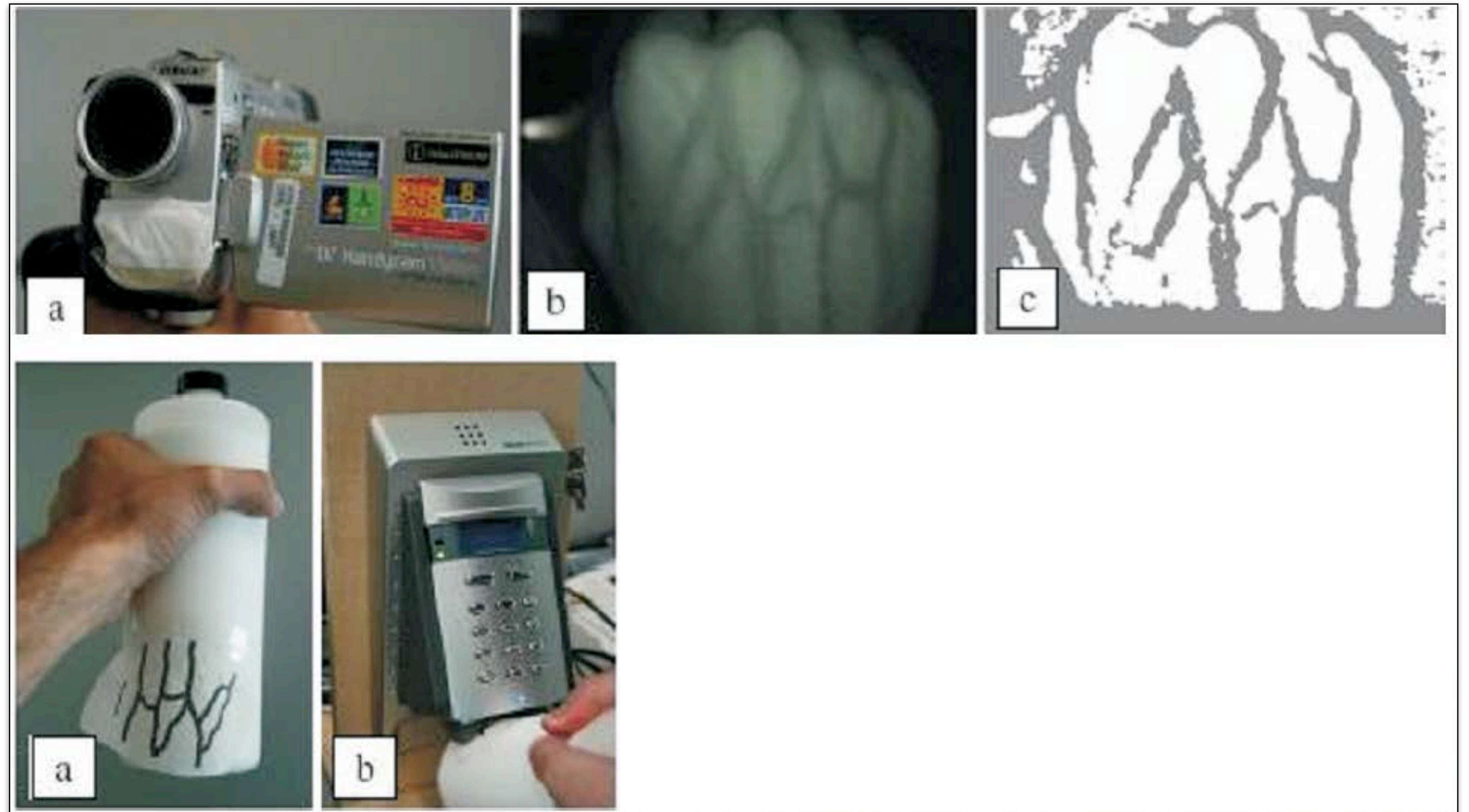IAPR 2005

Vein Recognition

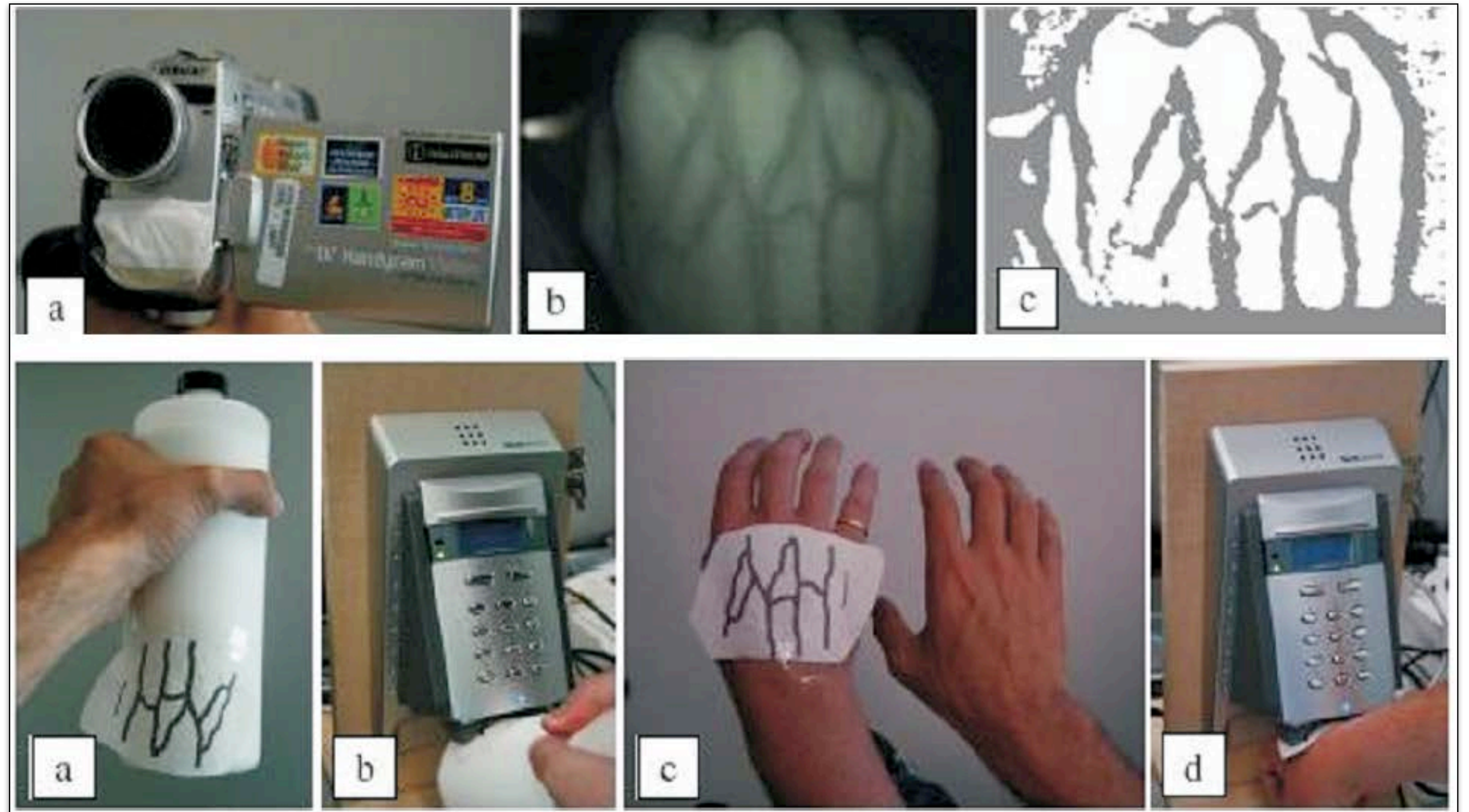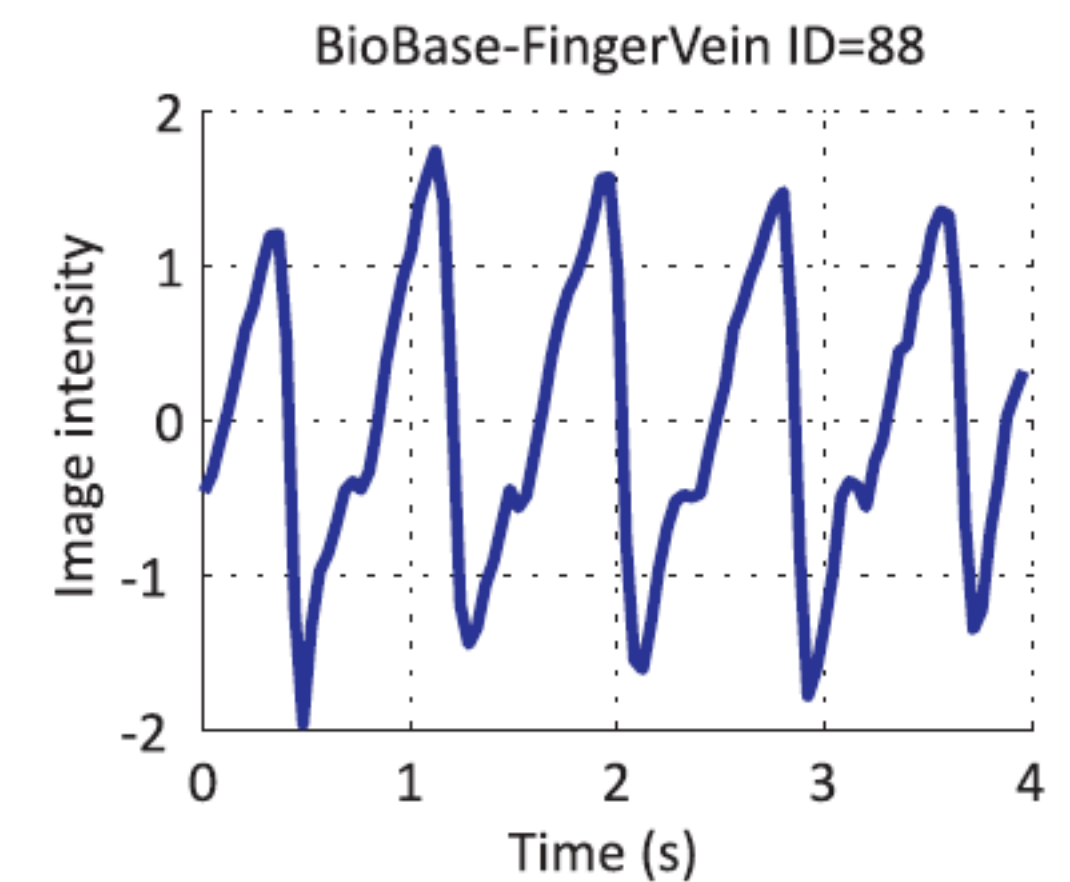**Presentation Attack**
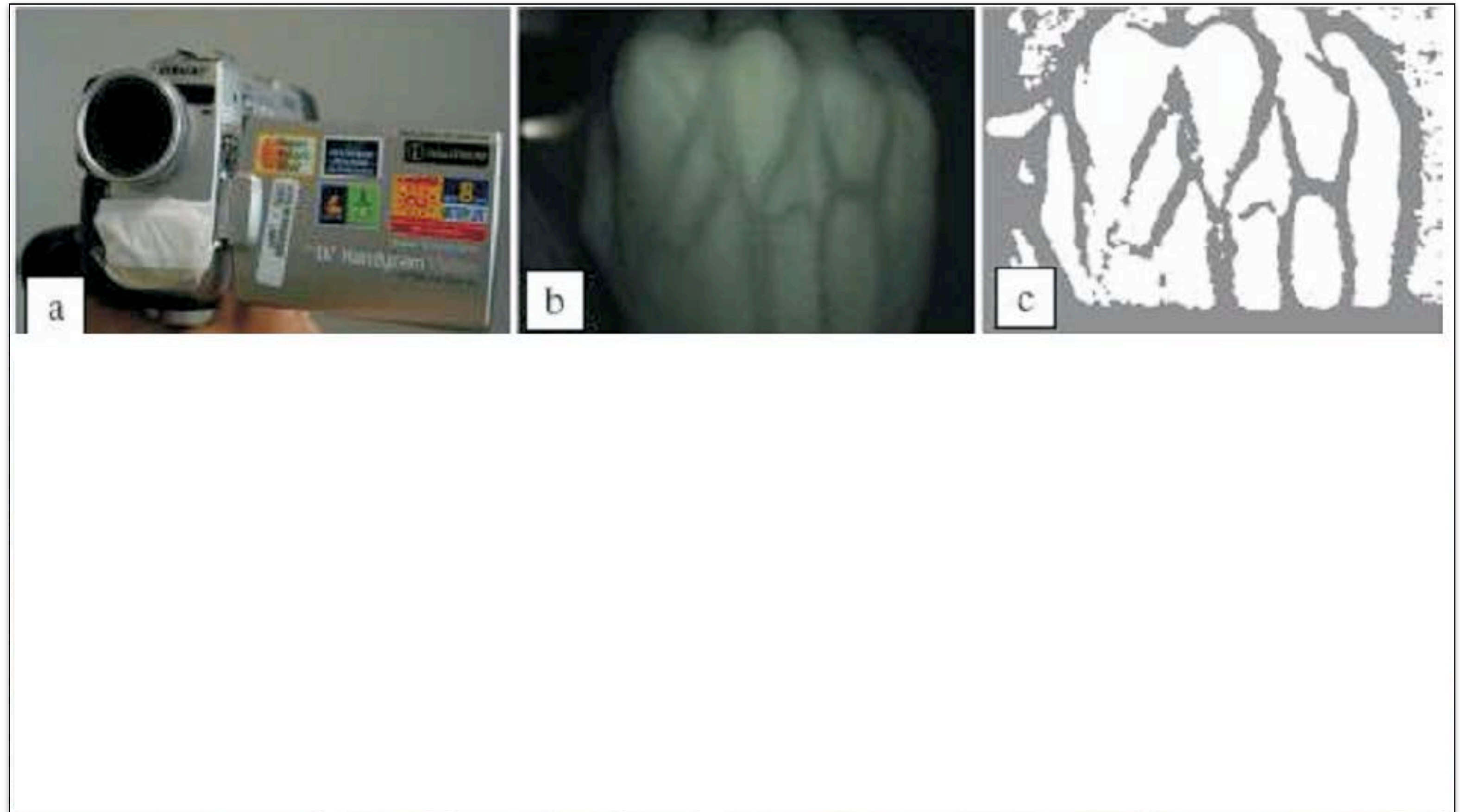
Vein Recognition

Presentation Attack
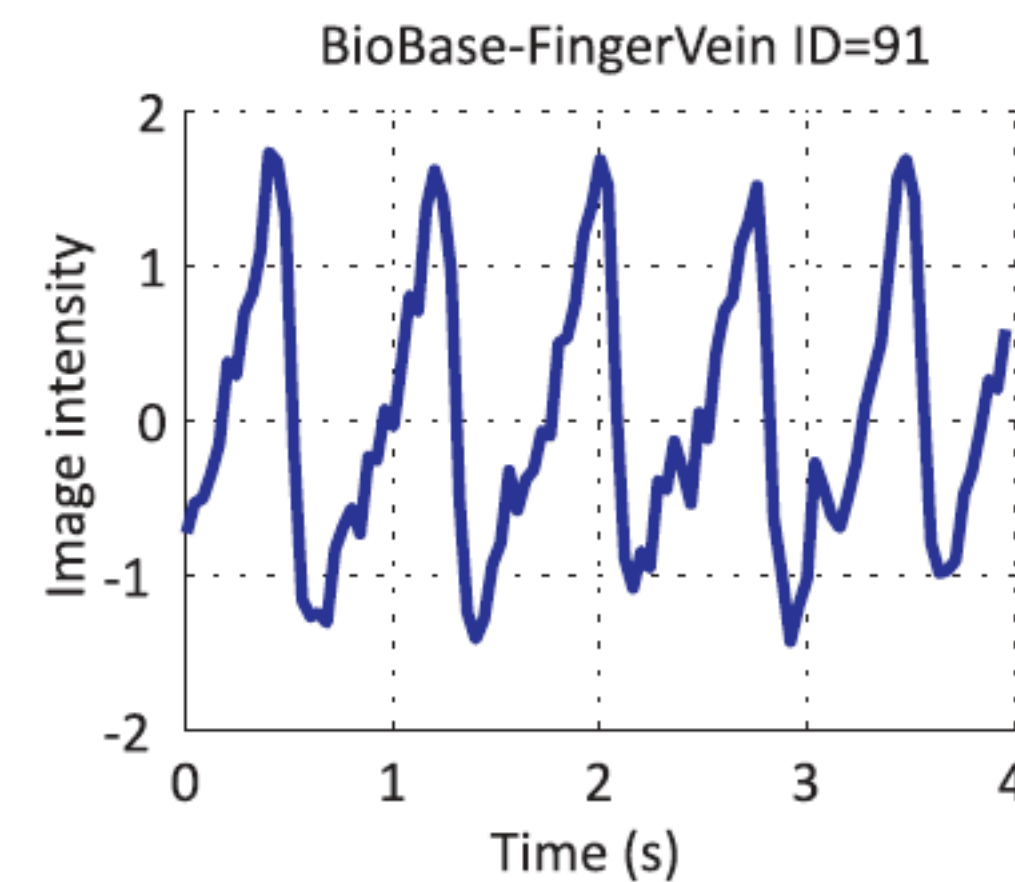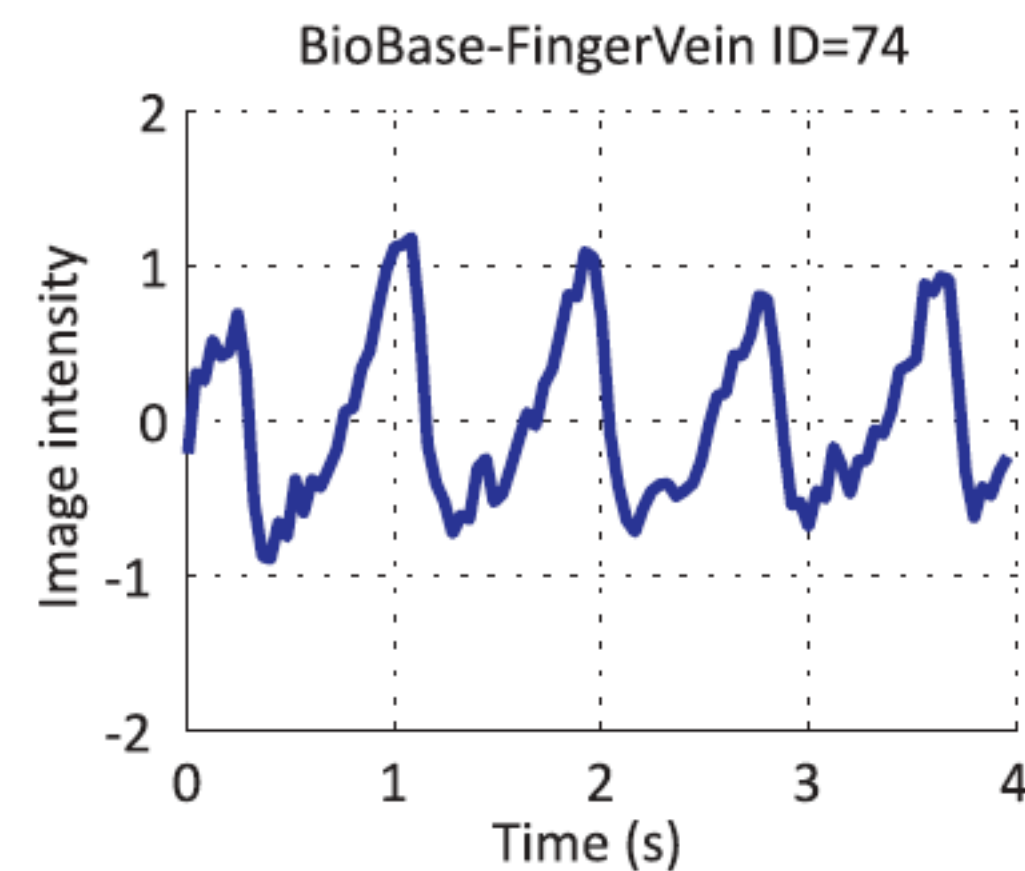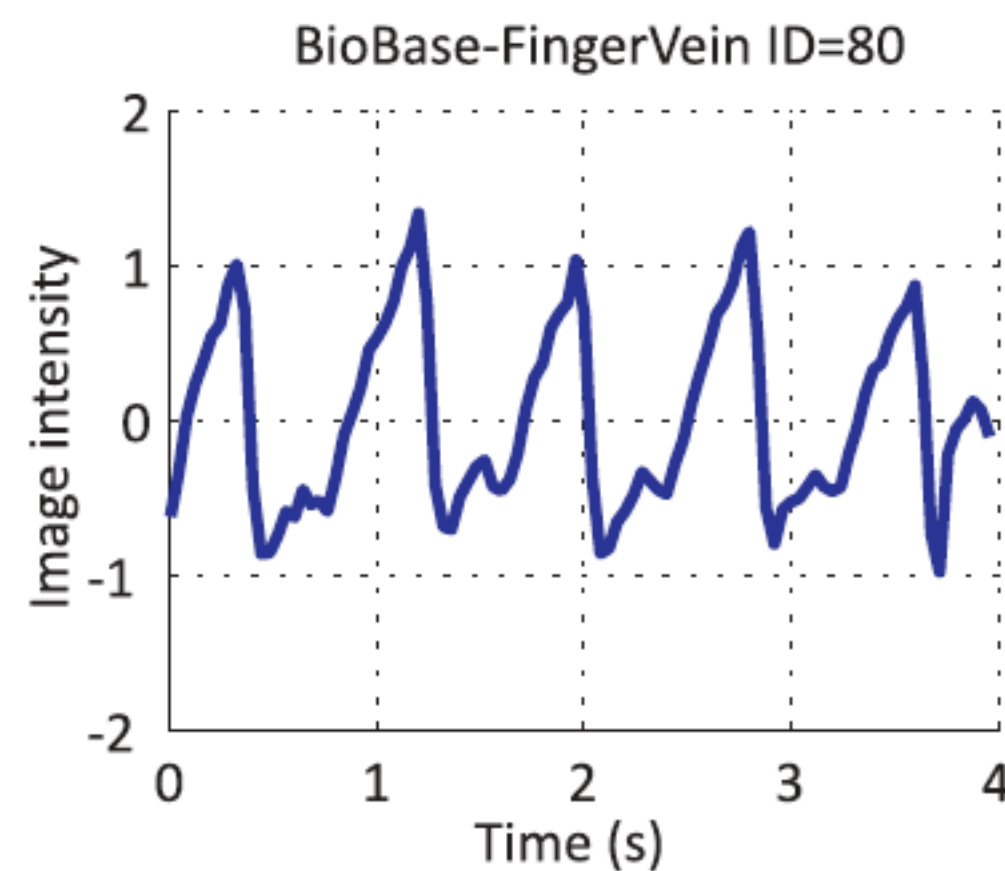
Vein Recognition

Presentation Attack

MITRE
State of the Art Biometrics
Excellence Roadmap
Tech. Report, 2008

Vein Recognition

Presentation Attack Detection

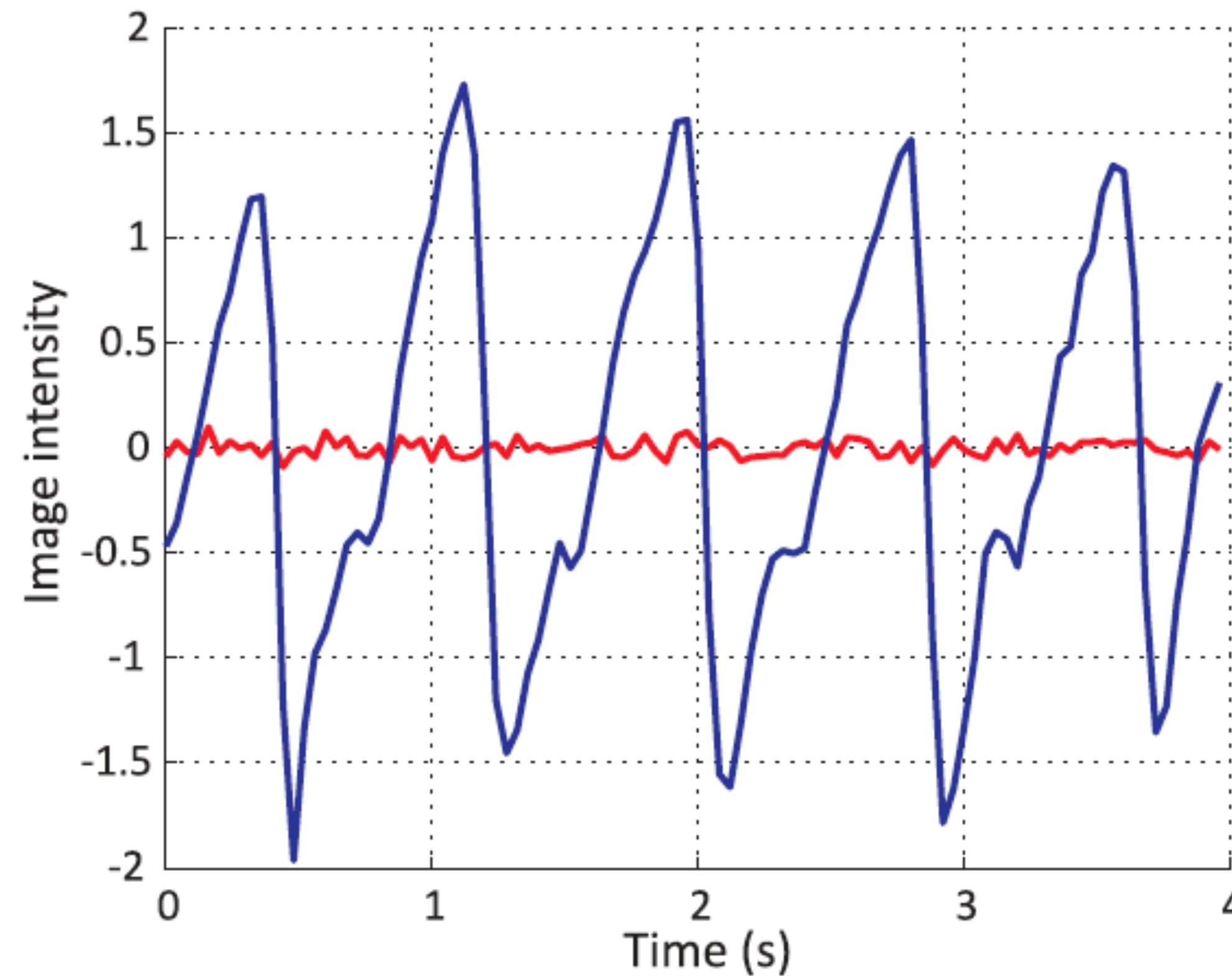Blood Pulse Detection   Dr. Adam Czajka

Vein Recognition

Presentation Attack Detection

Blood Pulse Detection
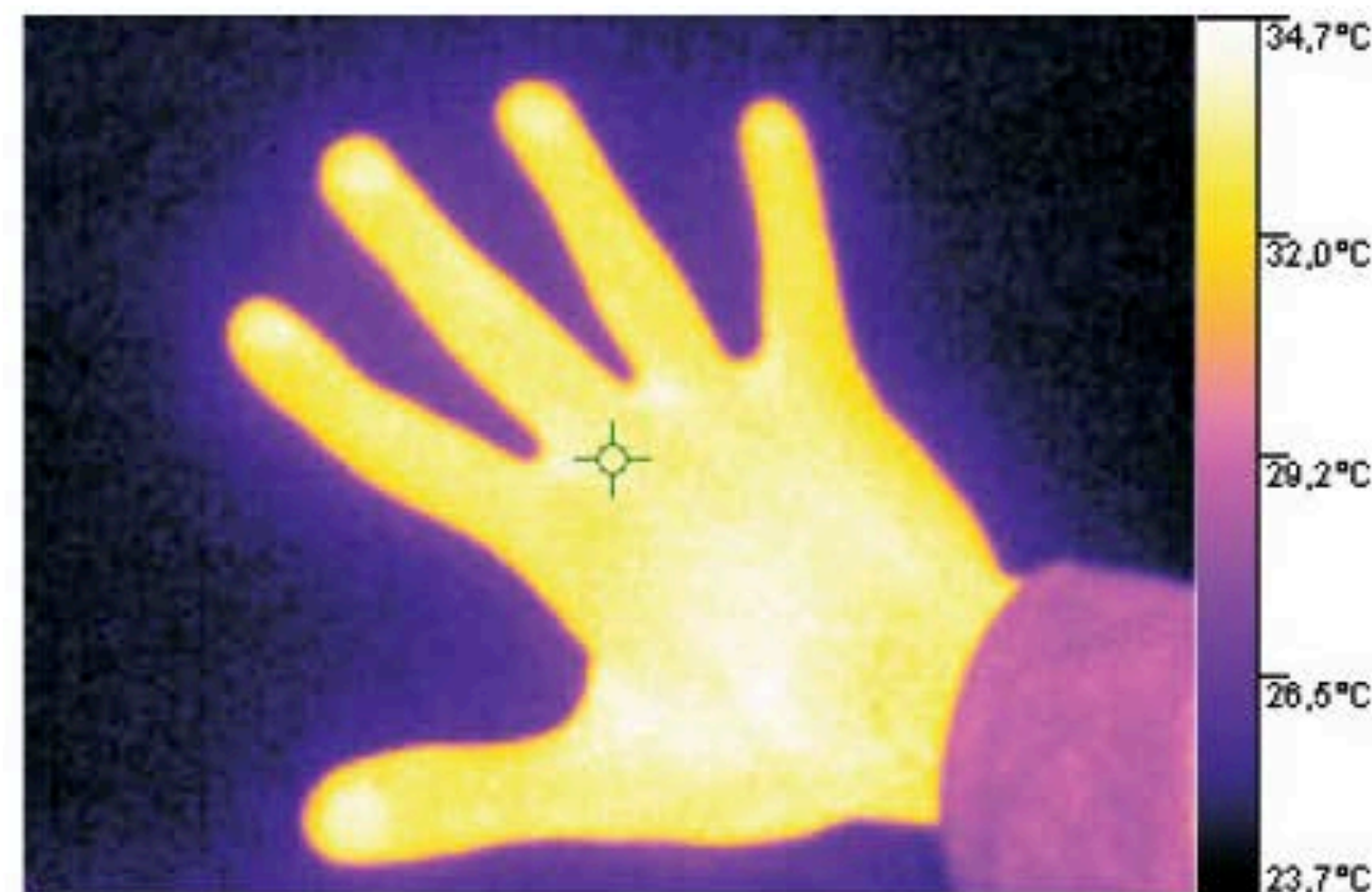
Dr. Adam Czajka

Forgery

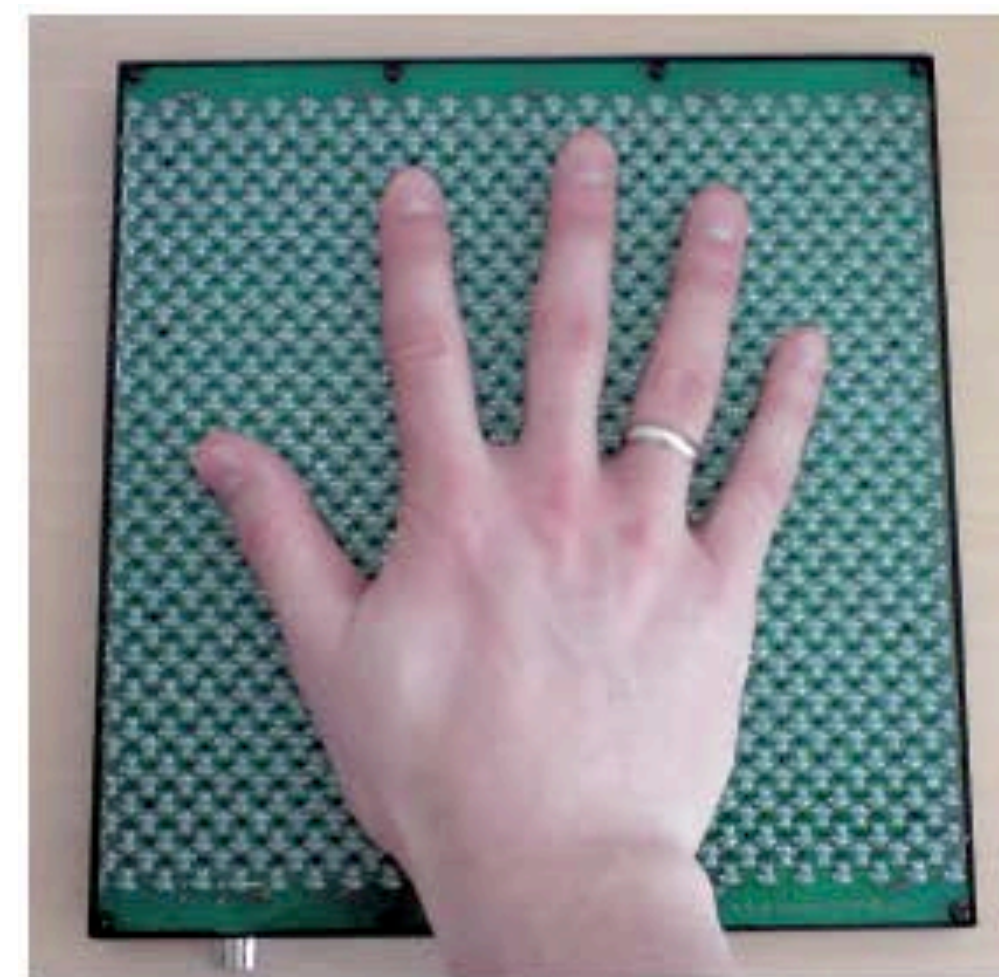# Vein Recognition

Presentation Attack Detection

Temperature Measurement   Dr. Adam Czajka
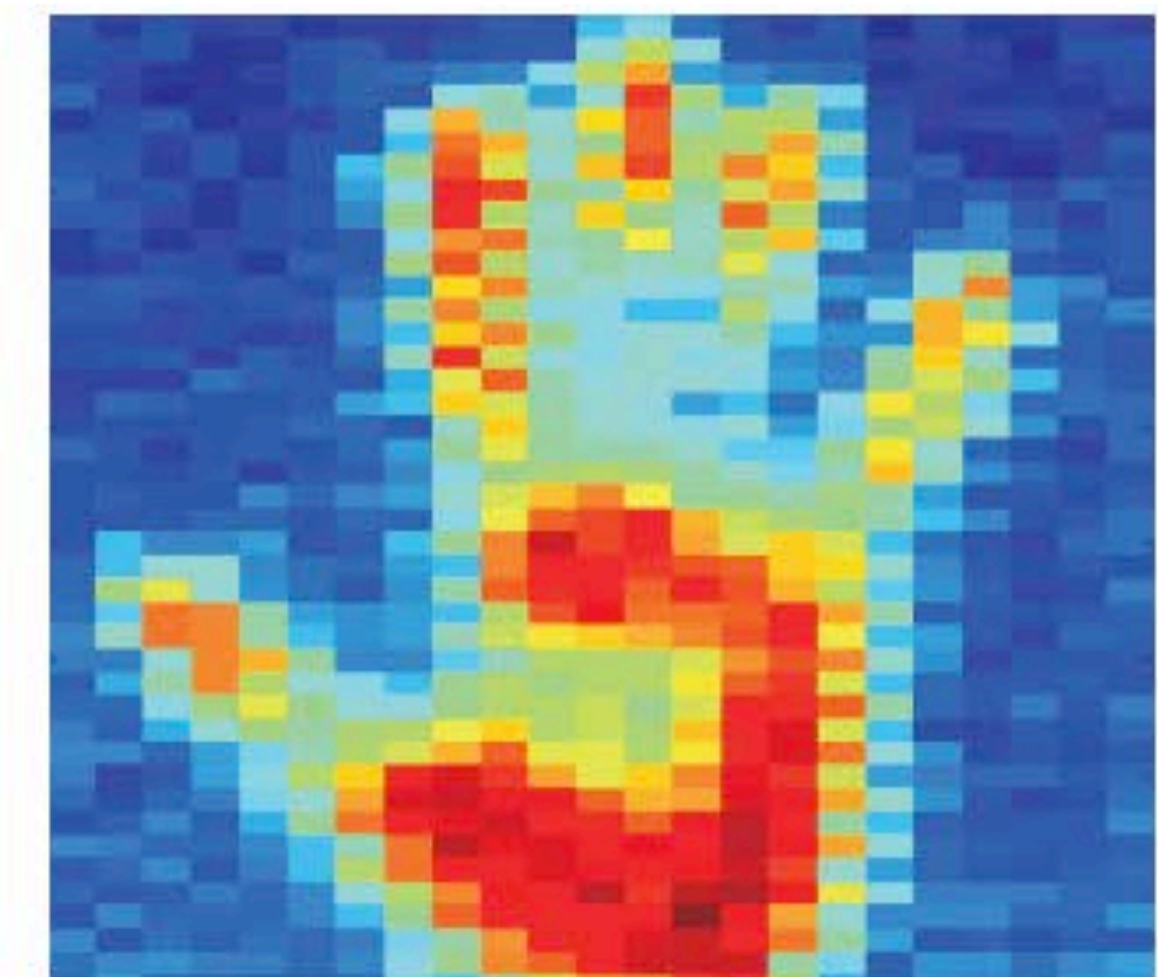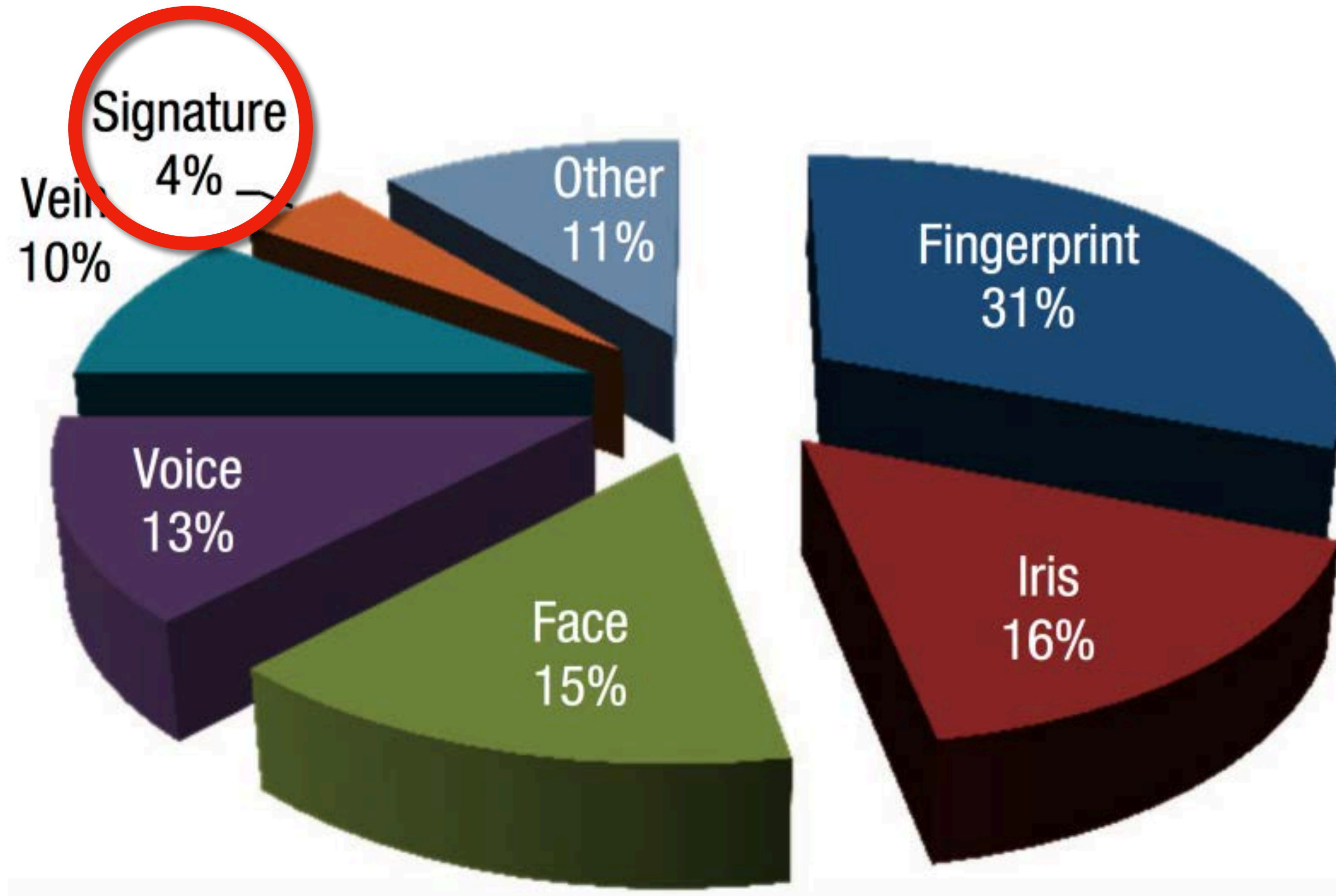

Raw thermal camera image

Matrix of thermal sensors

Raw matrix image

Alternative Traits

Market

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

Signature Recognition

Behavioral Trait

Signature Recognition

Acquisition

Off-line

On-line

https://www.youtube.com/watch?v=YI44gtOo7Xw

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Signature Recognition

Off-line Acquisition

Based on visual content only.

General-purpose sensor
(e.g., scanner, camera).
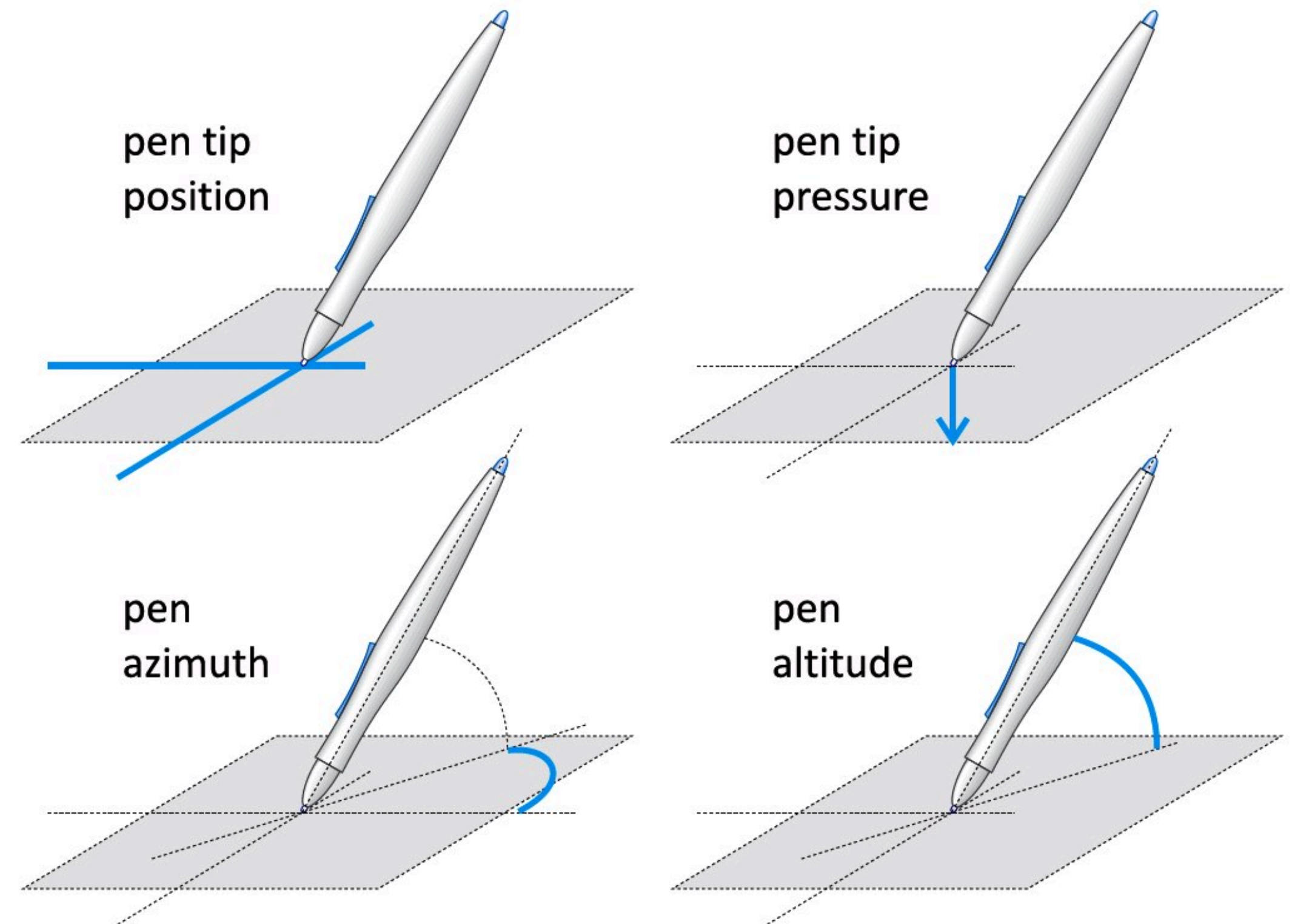
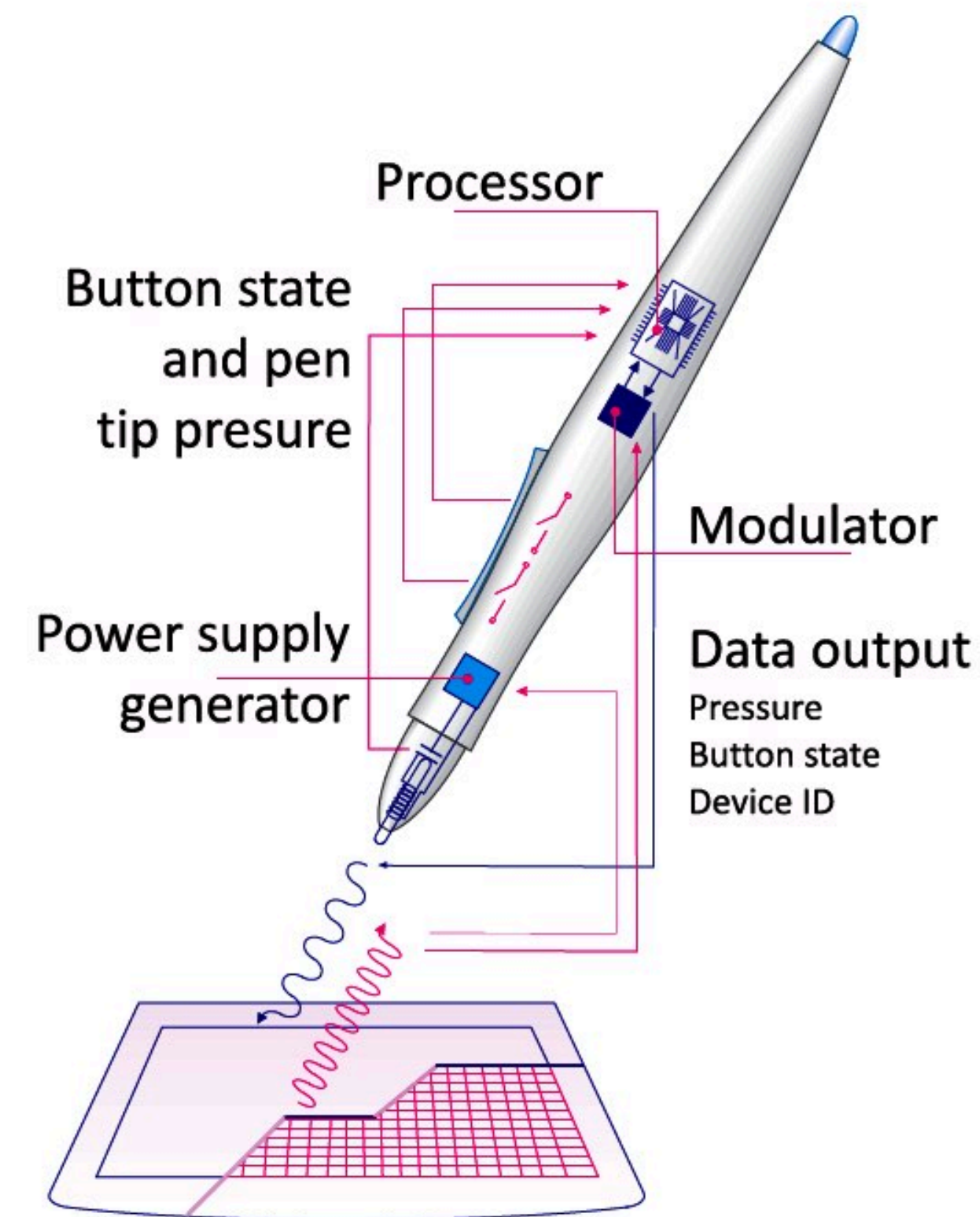Not necessarily aided by a computer.

https://www.youtube.com/watch?v=NPf2otAxB8U

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Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.

pen tip position

pen tip pressure

pen azimuth

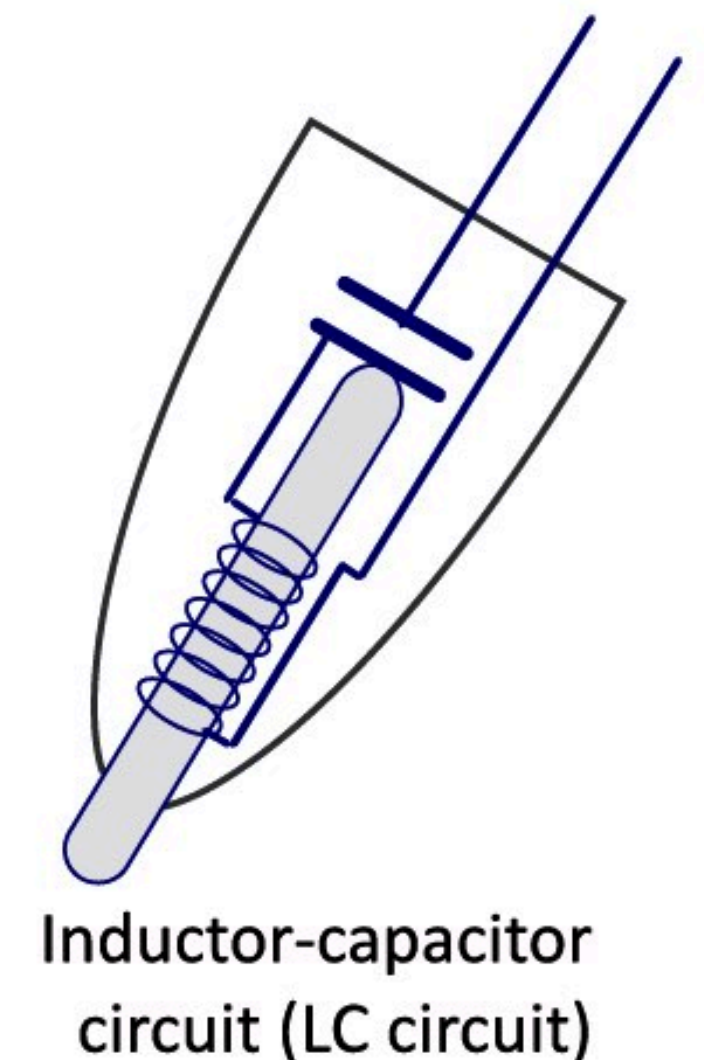pen altitude

Dr. Adam Czajka

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Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.

Special sensors
(such as digitizing tablets).

Dr. Adam Czajka

Processor

Button state and pen tip presure

Modulator

Power supply generator

Data output
Pressure
Button state
Device ID

Inductor-capacitor circuit (LC circuit)

Signature Recognition

On-line Acquisition

Various components are captured
from the signing behavior.

Special sensors
(such as digitizing tablets).

Dr. Adam Czajka

Aided by computer
(*acquisition*, *enhancement*, *feature extraction*, *matching*, *decision*).

Signature Recognition

On-line Acquisition

Signature Tokens

Dr. Adam Czajka

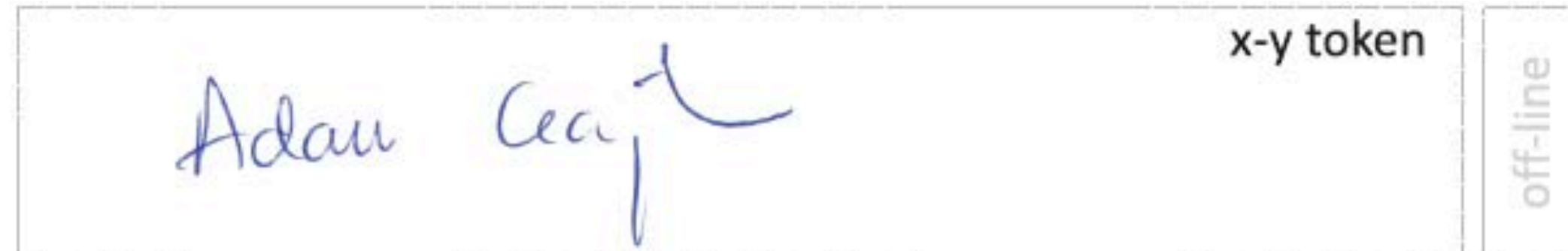# Signature Recognition

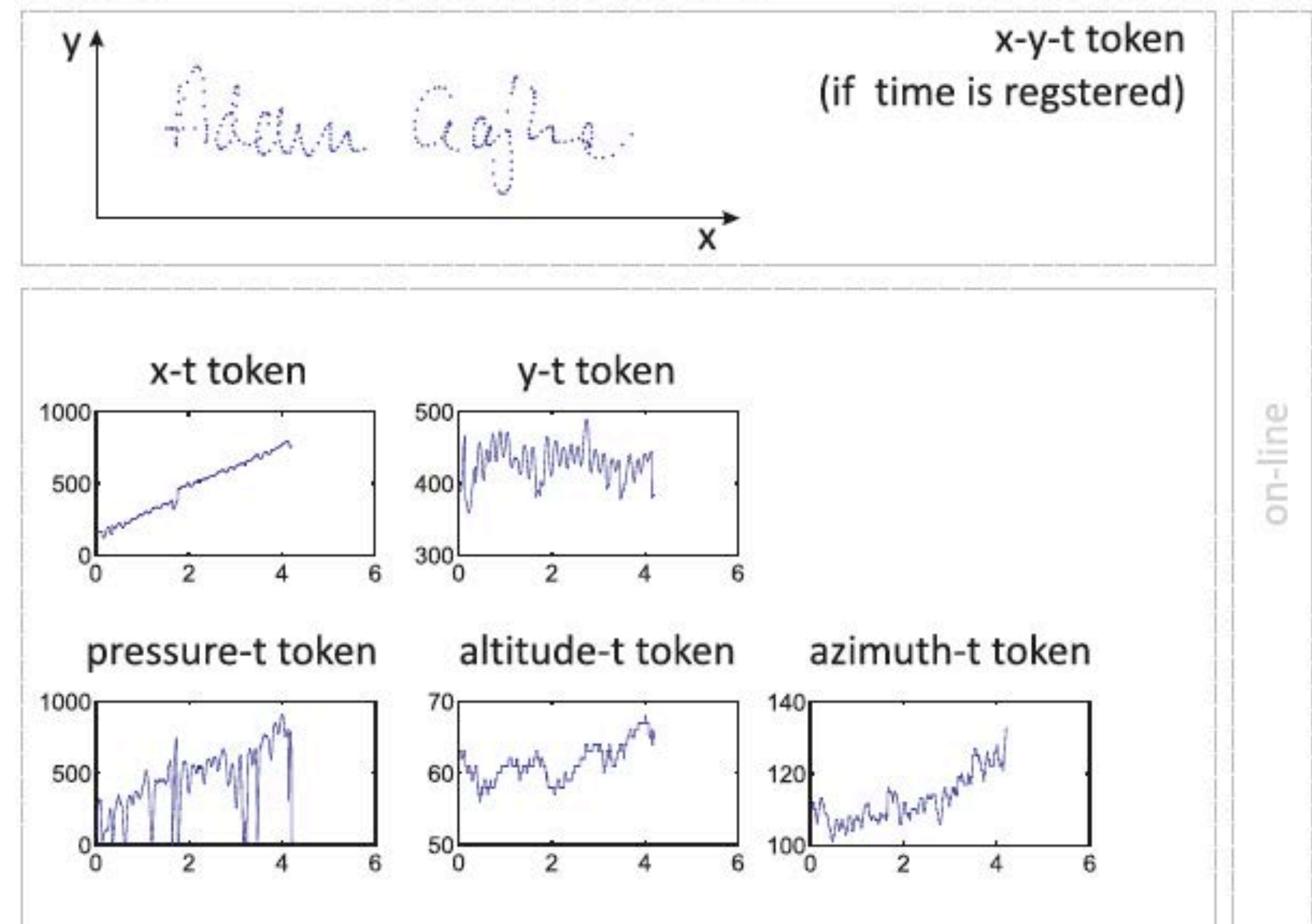**On-line Acquisition**

Signature Tokens

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Signature Recognition

On-line Acquisition
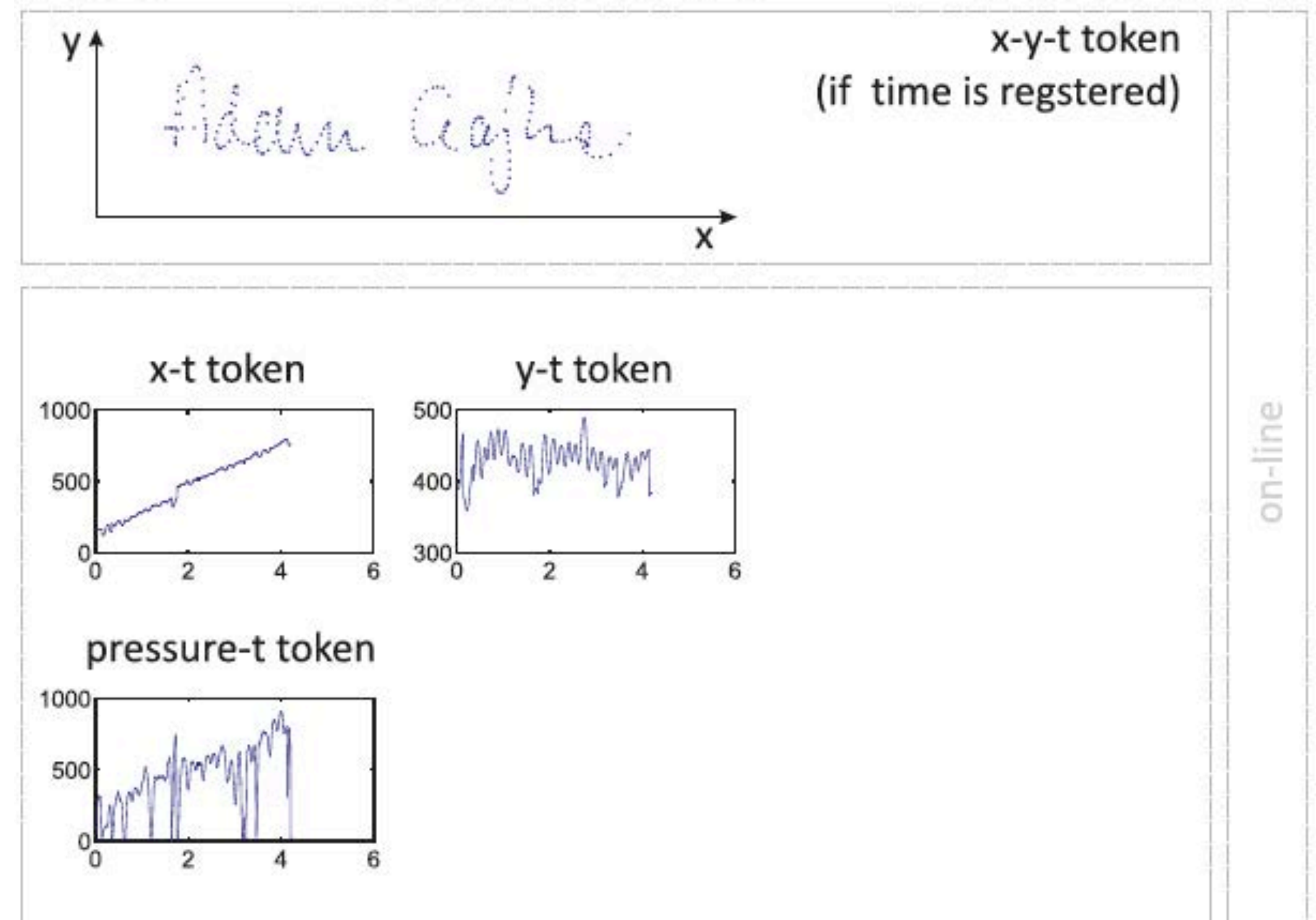
Signature Tokens

Dr. Adam Czajka

Signature Recognition

On-line Acquisition

Signature Tokens

Dr. Adam Czajka

Signature Recognition

Presentation Attack

genuine token

Signature Recognition

Presentation Attack

genuine token

random forgery

Whatever, dude.

Signature Recognition

Presentation Attack
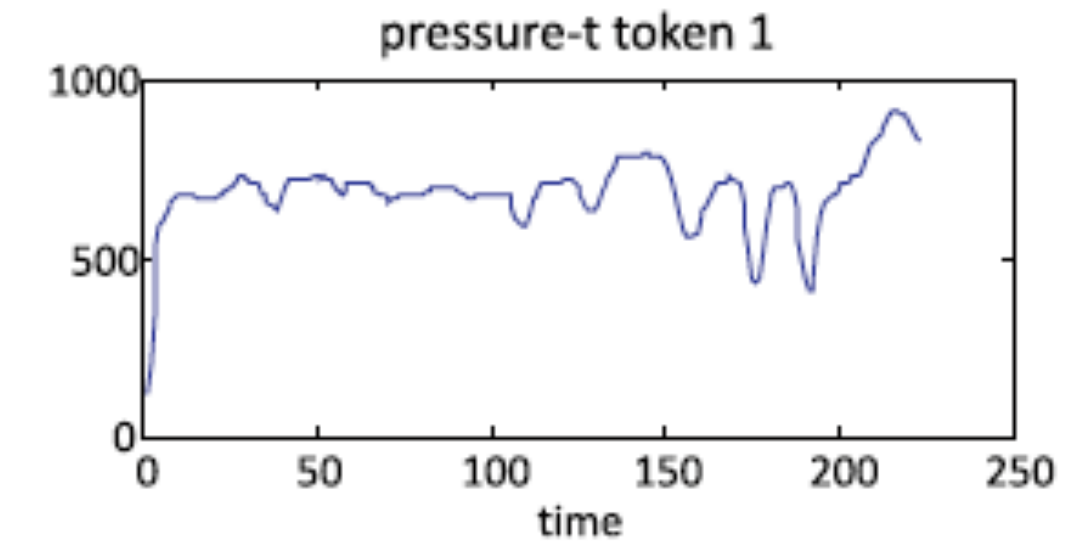
Signature Recognition
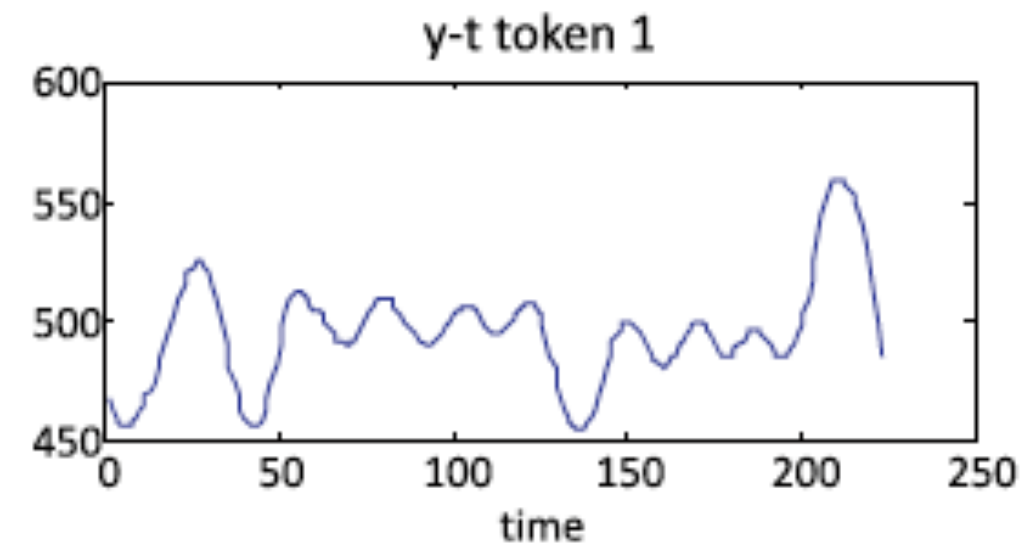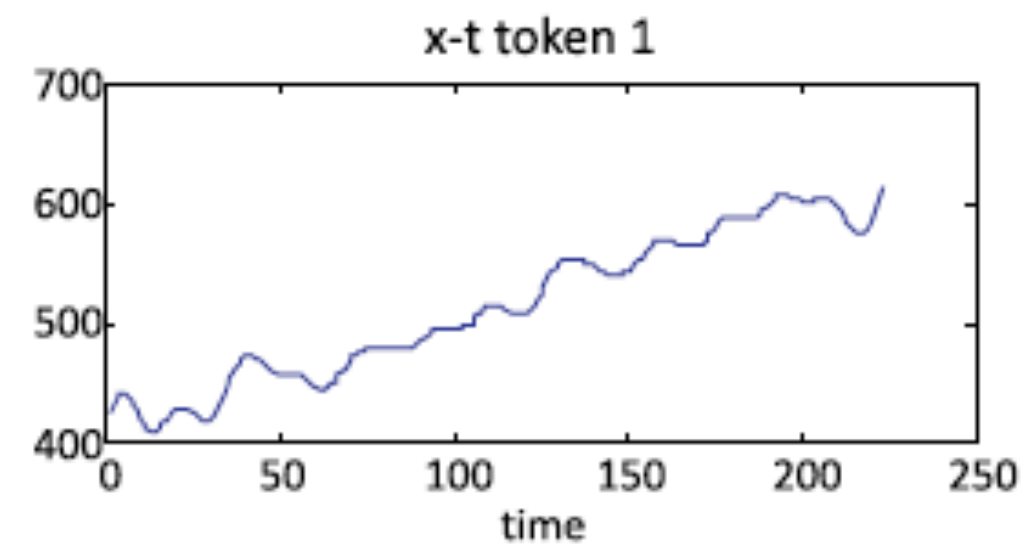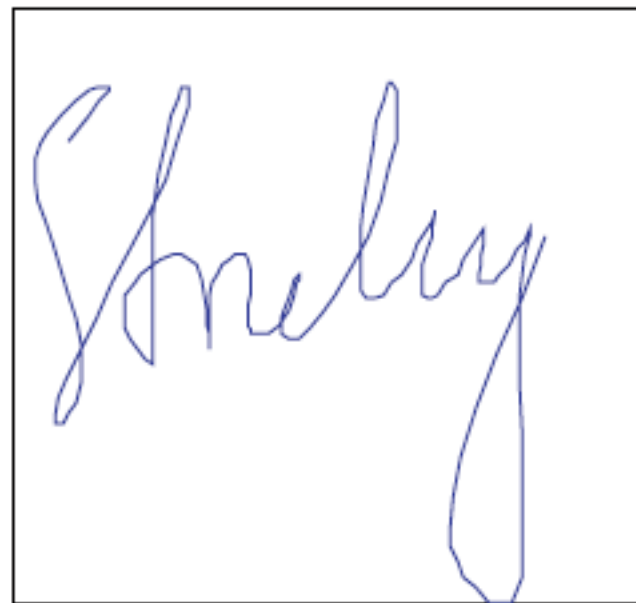
Presentation Attack

Signature Recognition

Presentation Attack Detection

Signature Recognition

Presentation Attack Detection

Signature Recognition

Presentation Attack Detection

Dr. Adam Czajka
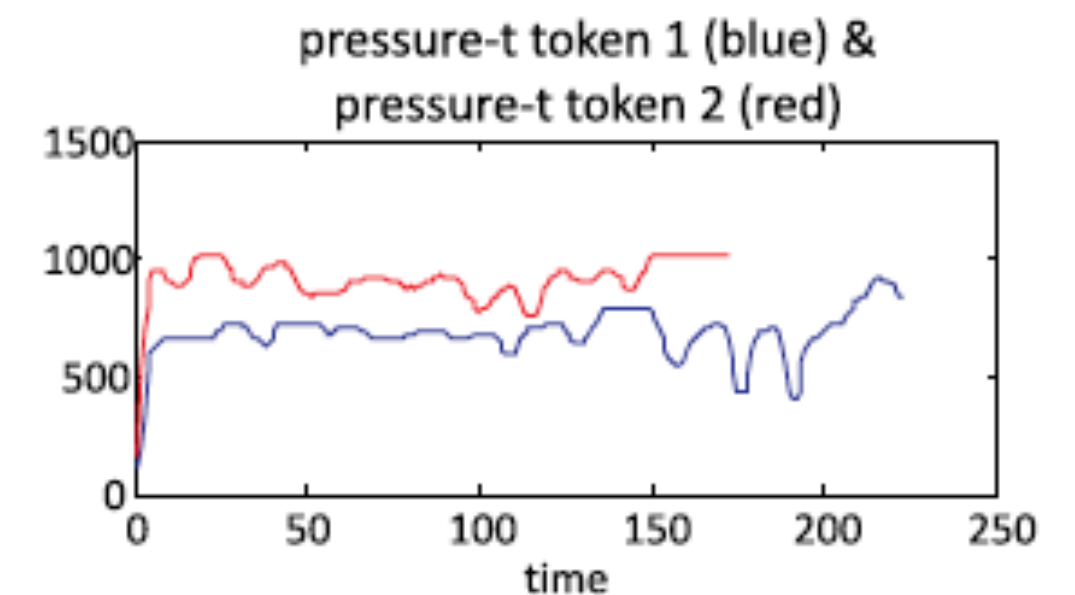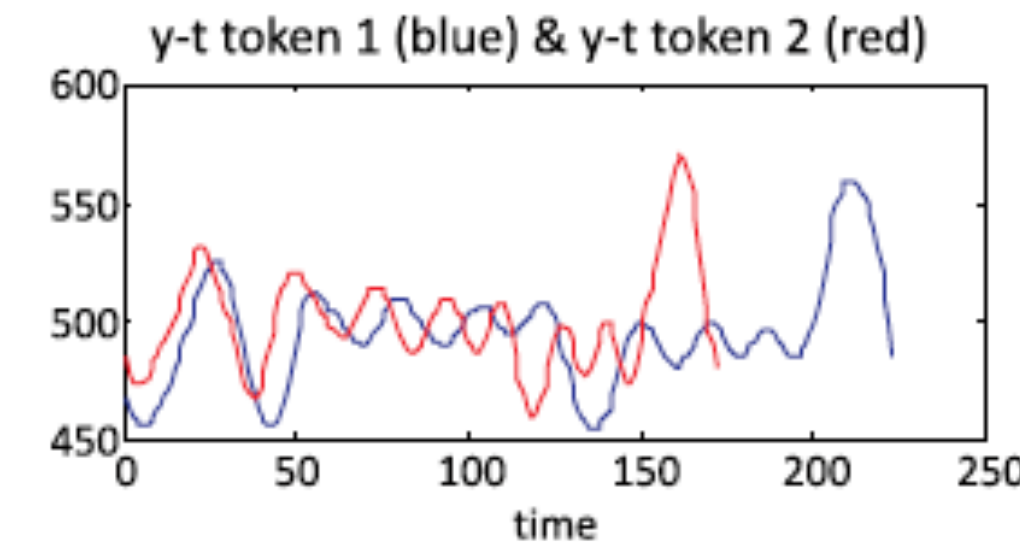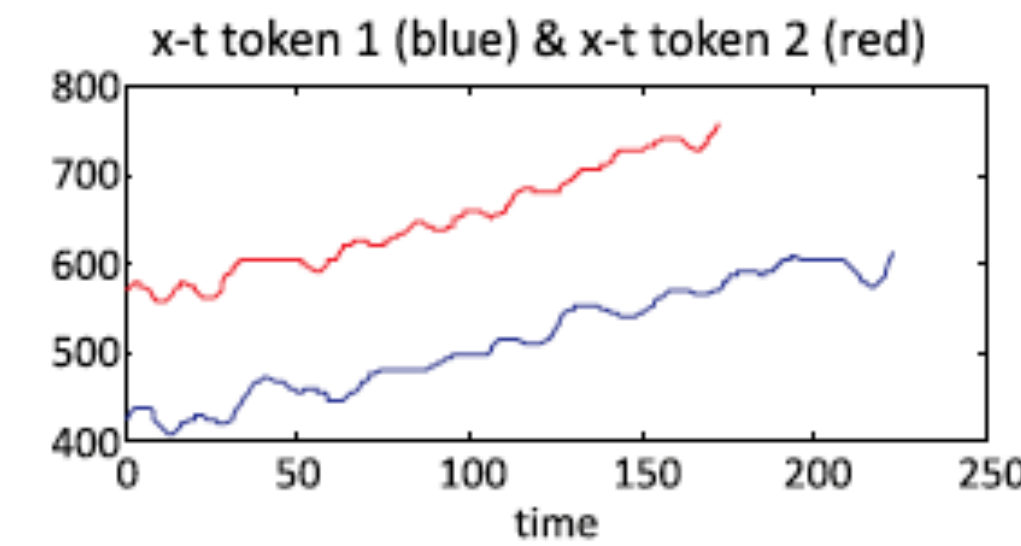
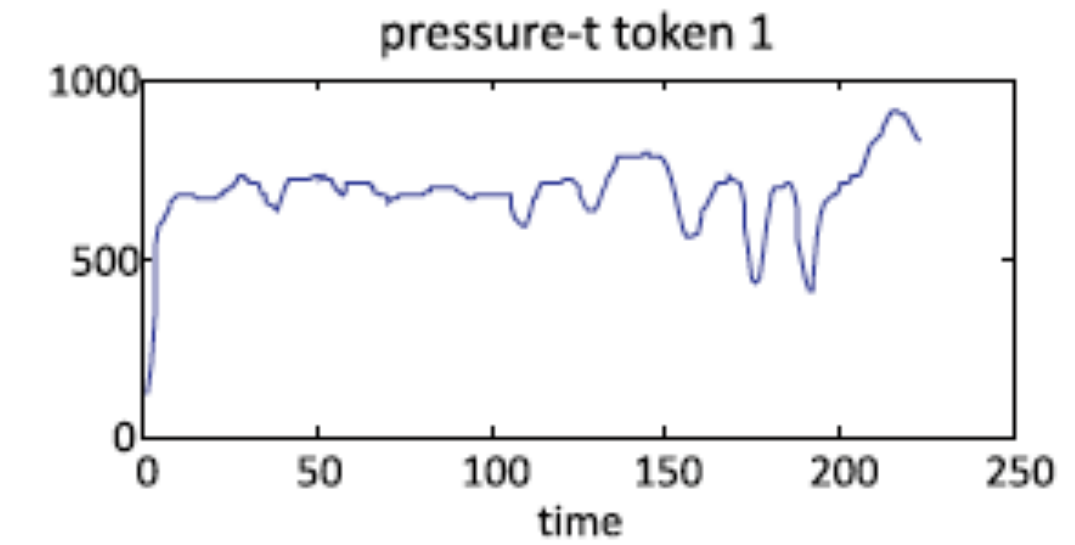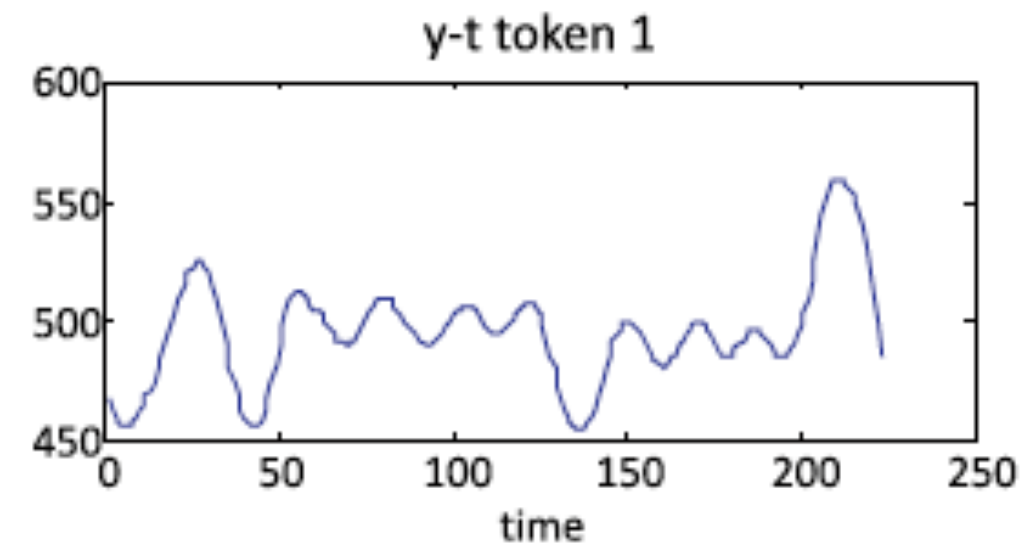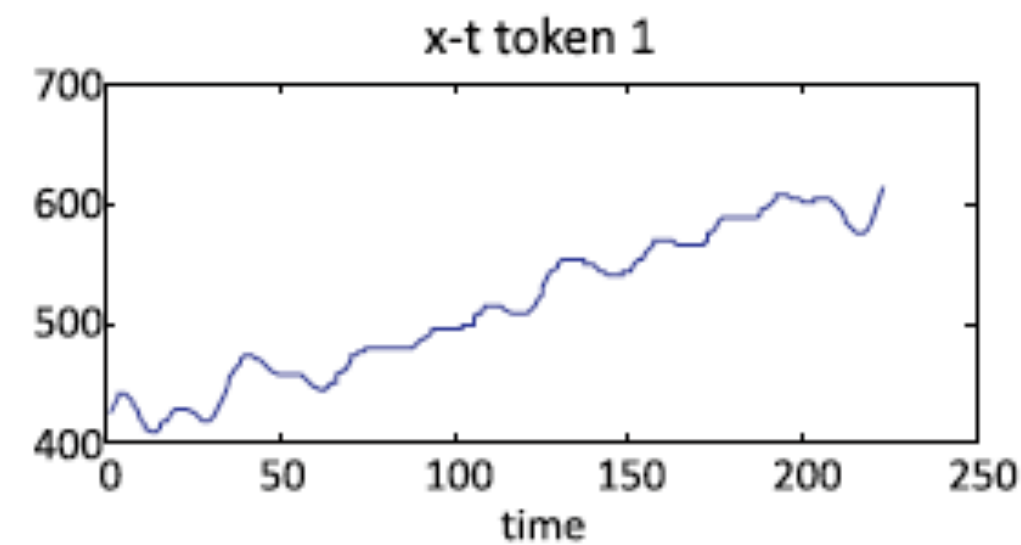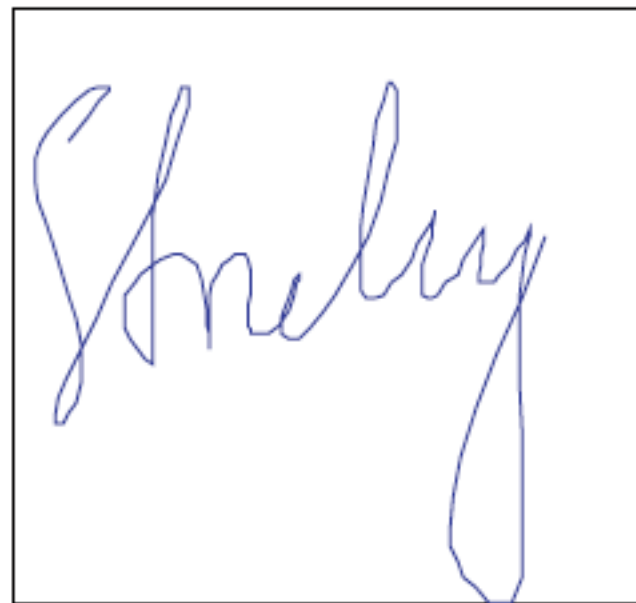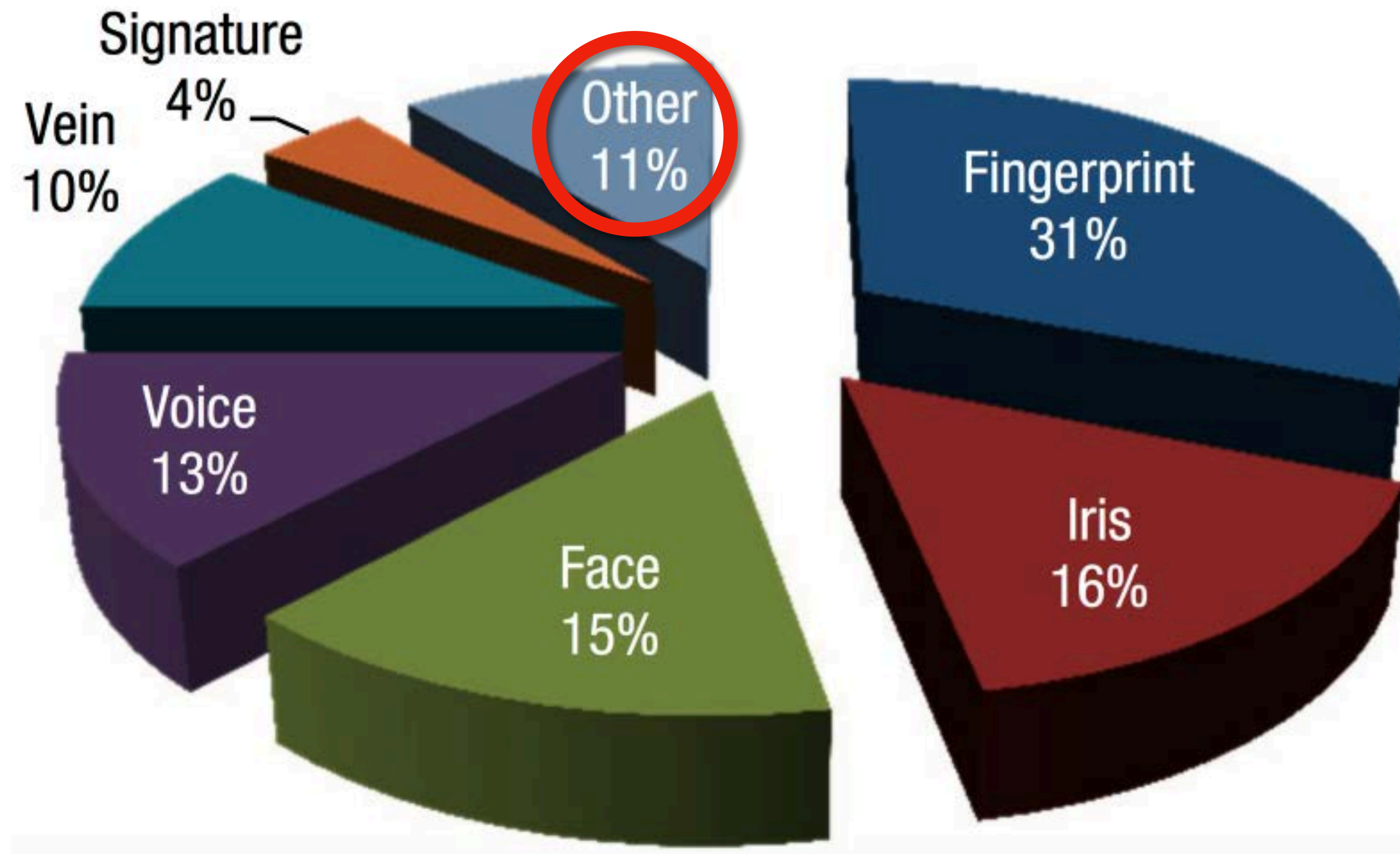# Alternative Traits

Market

Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

Palmprint Recognition

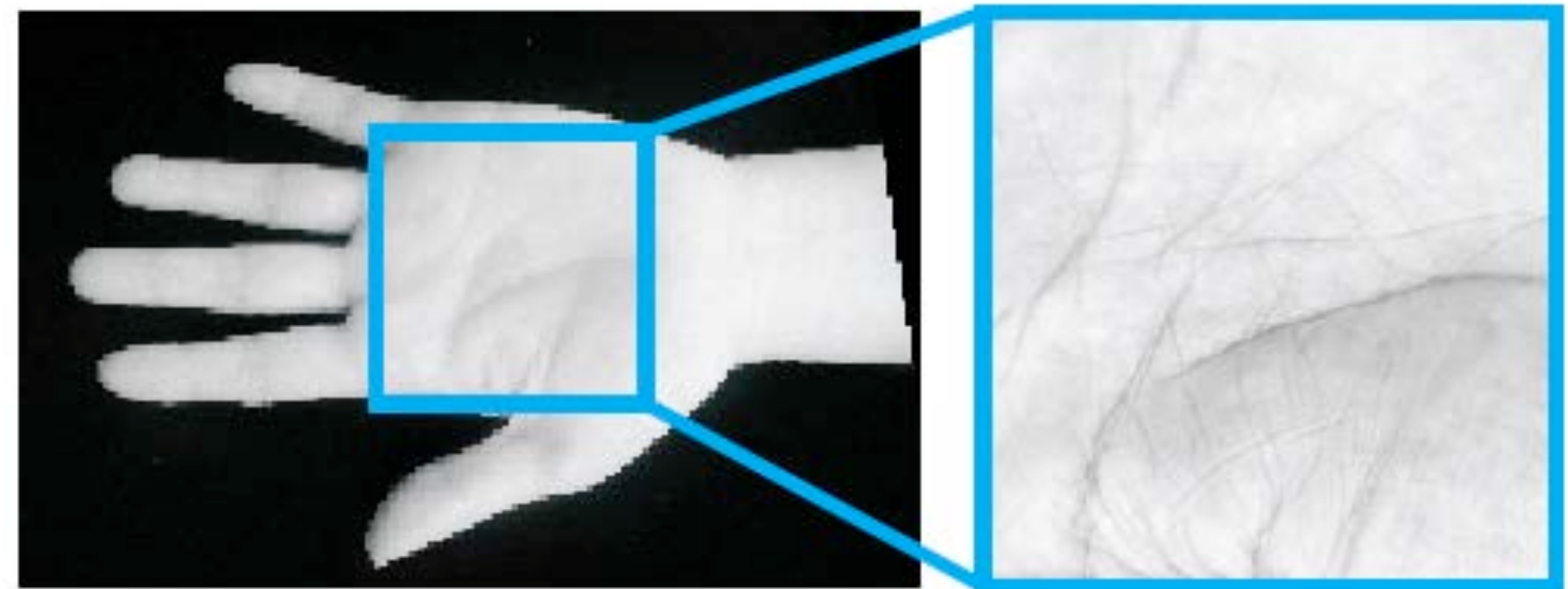**Level-1 Features**

Main Lines

Yes: Direction, bifurcations, endings, and crossings.

No: "line of life", "line of fate", you name it.

Dr. Adam Czajka

Palmprint Recognition

Level-2 Features

Minutiae

Ridge endings and bifurcations (position and angle).

Focus on the inner and side portion of the hand.

Palmprint Recognition

On-line Acquisition

CrossMatch ID 2500
Dr. Adam Czajka
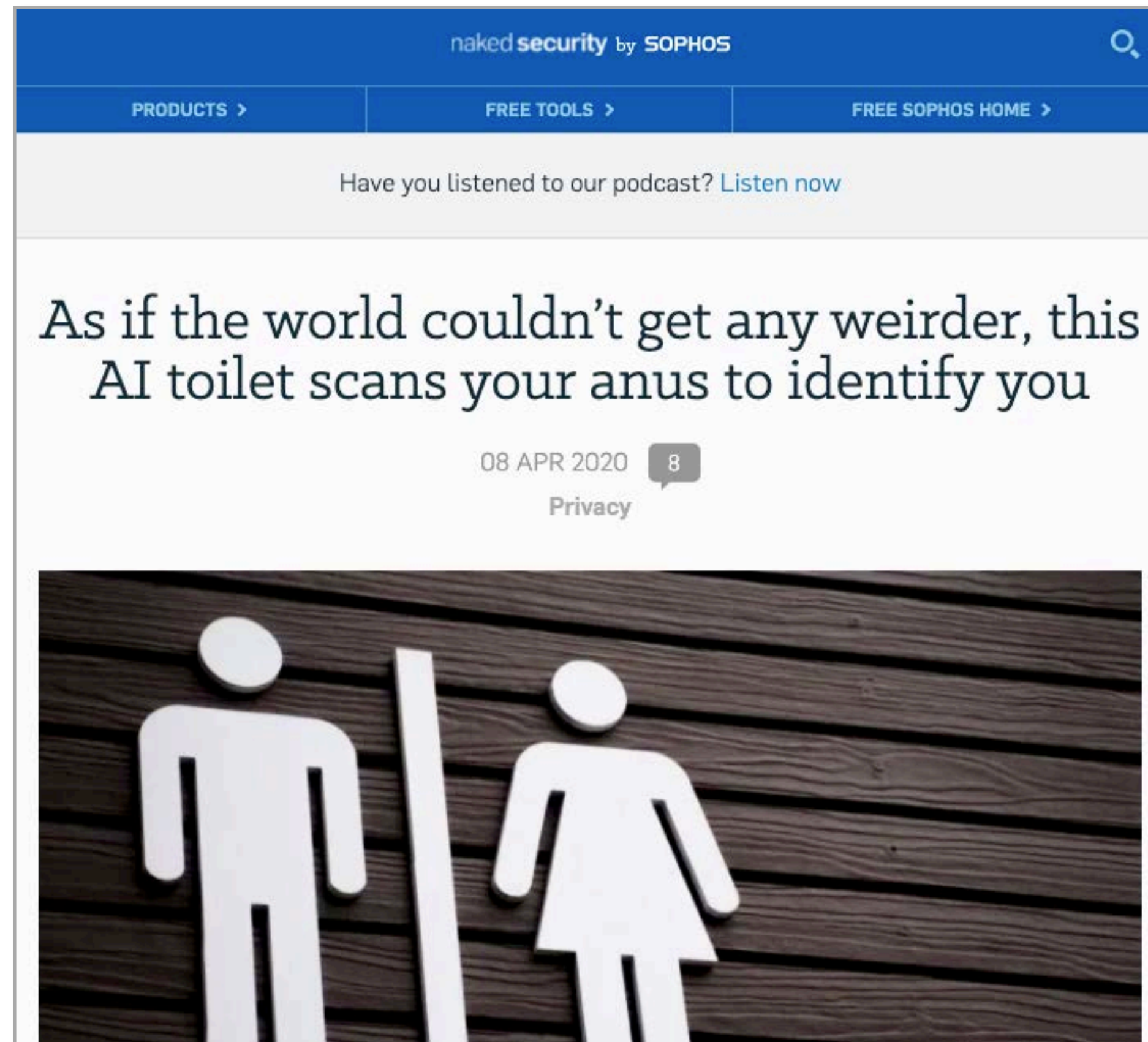
Other Traits
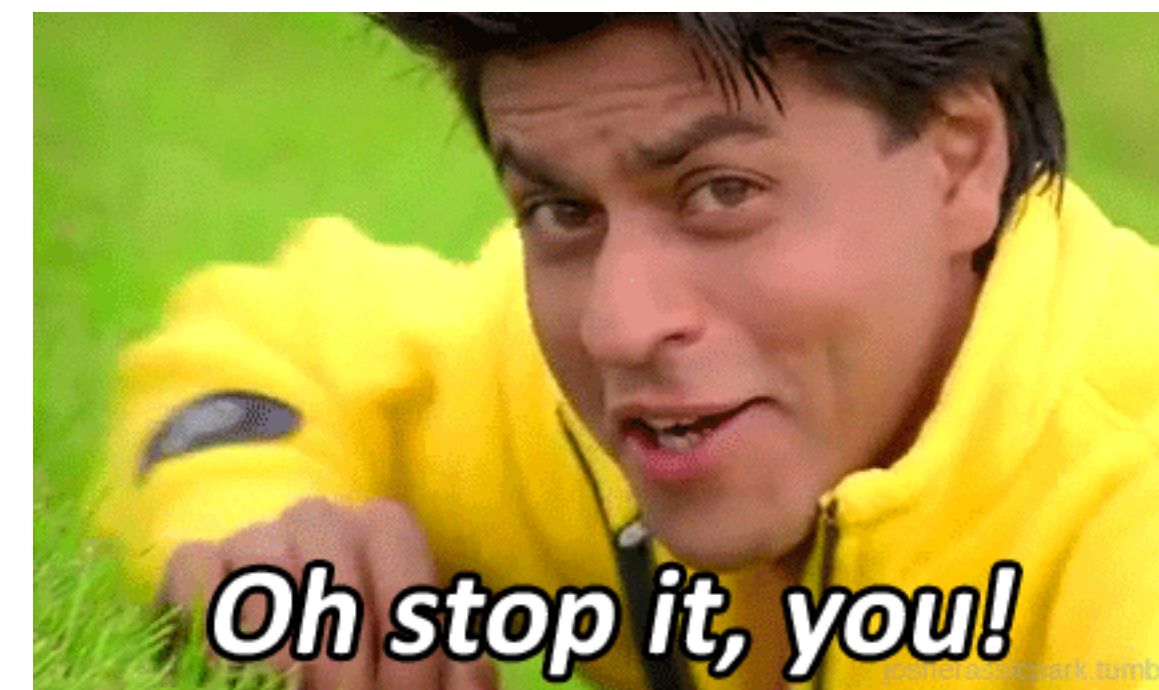

DNA

Gate

Ears

Tongue Print

Other Traits

Ahem…

https://nakedsecurity.sophos.com/
2020/04/08/as-if-the-world-couldnt-get-
any-weirder-this-ai-toilet-scans-your-
anus-to-identify-you/

Soft Biometrics

What is it?
Usage of ancillary information to aid recognition.

Soft Biometrics

What is it?
Usage of ancillary information to aid recognition.

Benefits
Recognition accuracy improvement
Recognition runtime reduction

Soft Biometrics

What is it?
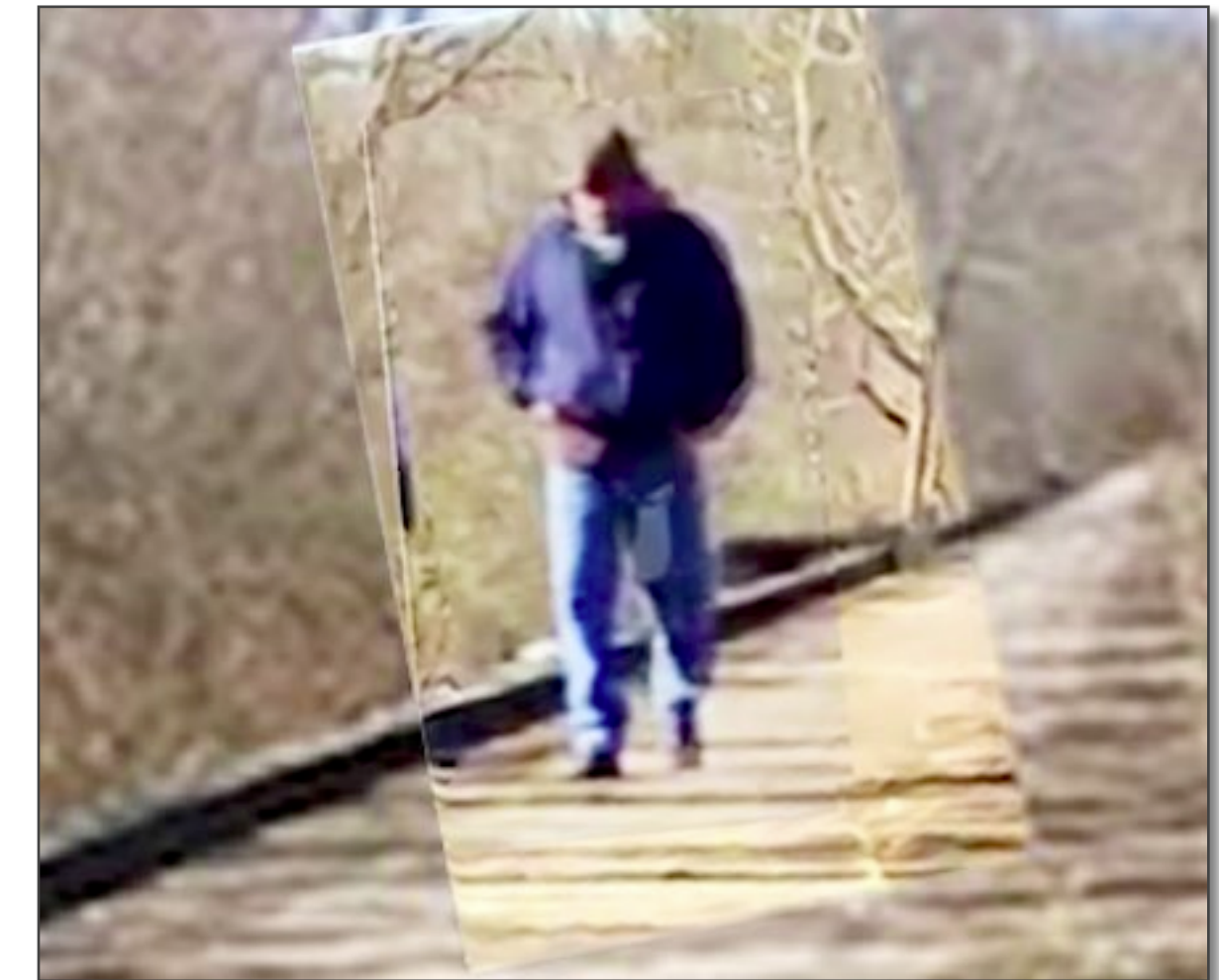Usage of ancillary information to aid recognition.

Benefits
Recognition accuracy improvement
Recognition runtime reduction

Limitation
Lack of uniqueness and permanence
Lack of universality
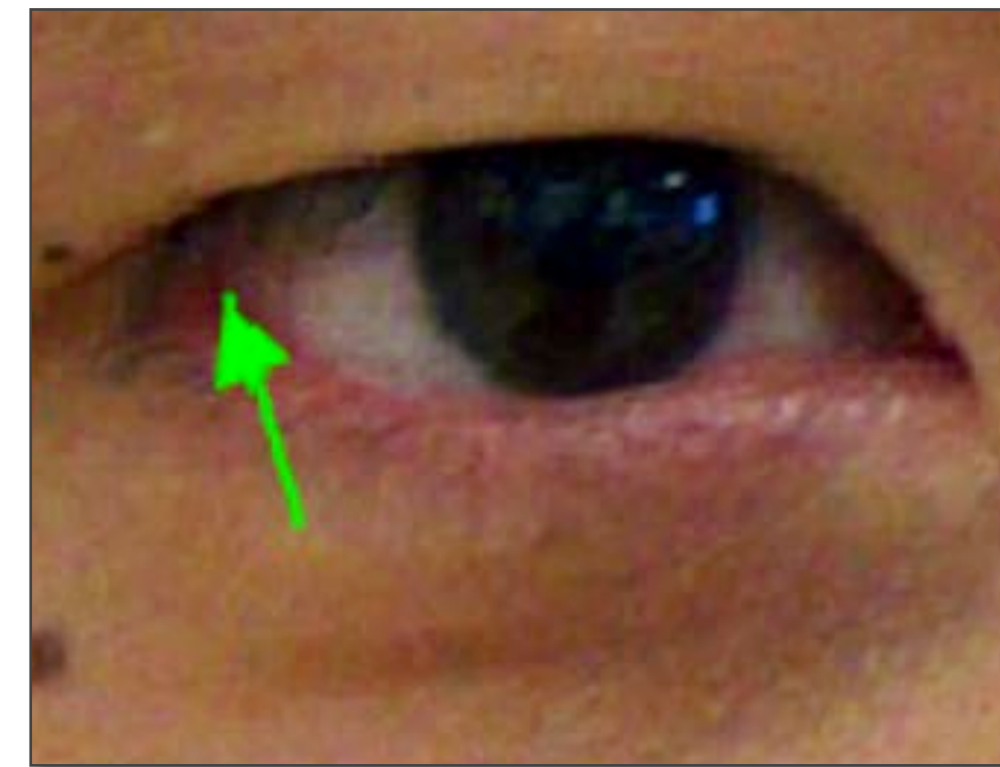

https://bit.ly/3u81gXd

Soft Biometrics

What can you guess?

Periocular region and eye color

Jain, Ross, and Nadakumar
Introduction to Biometrics
Springer Books, 2011

Gender?
Ethnicity?
Age?

Soft Biometrics

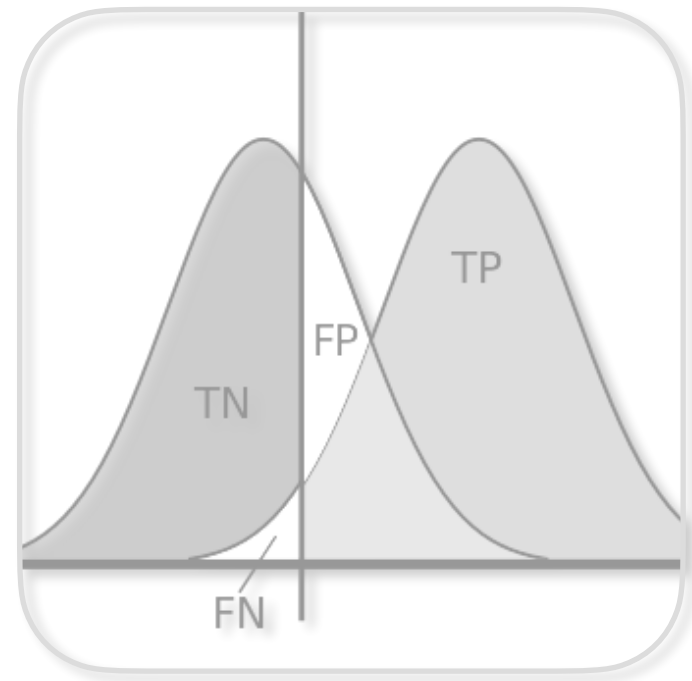**Other traits**

moles, scars, marks
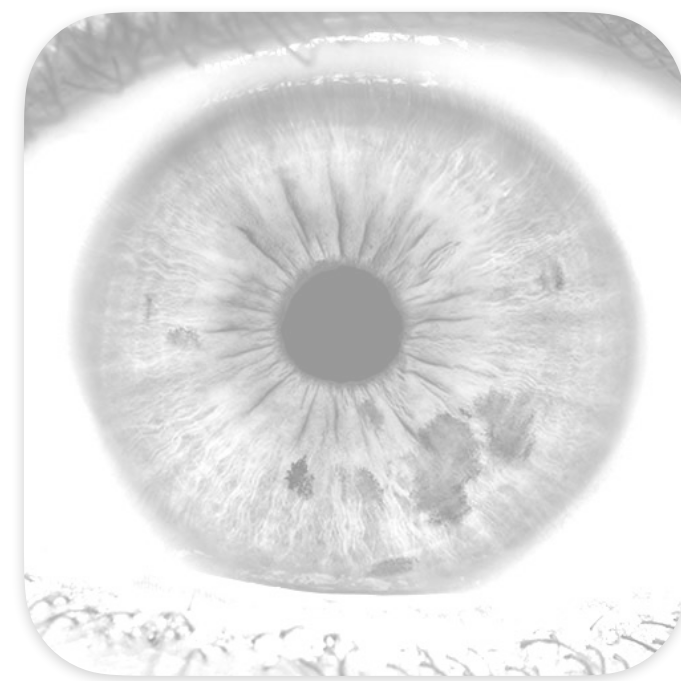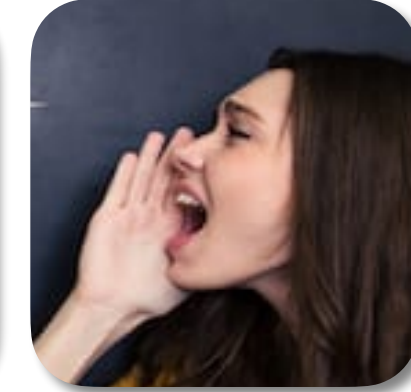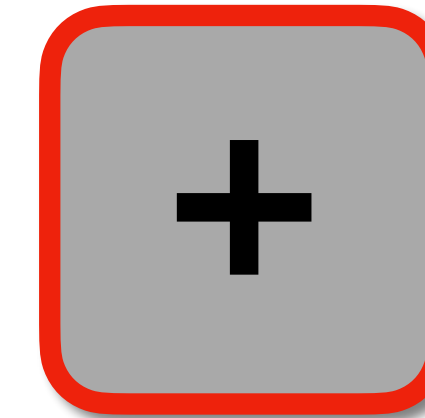

birthmarks

tattoos

What's Next?

Fusion (a.k.a. Multibiometrics)

Basics
Concepts
Metrics
Metric
implementation

Core Traits (3)
Concepts
Baseline implementation
Data collection
Evaluation
Attacks
Assignments

Alternative Traits and
Fusion
Concepts

Invited Talks (2)
State of the art
Future work