

Other Traits

CSE 40537/60537 Biometrics

Daniel Moreira
Spring 2022

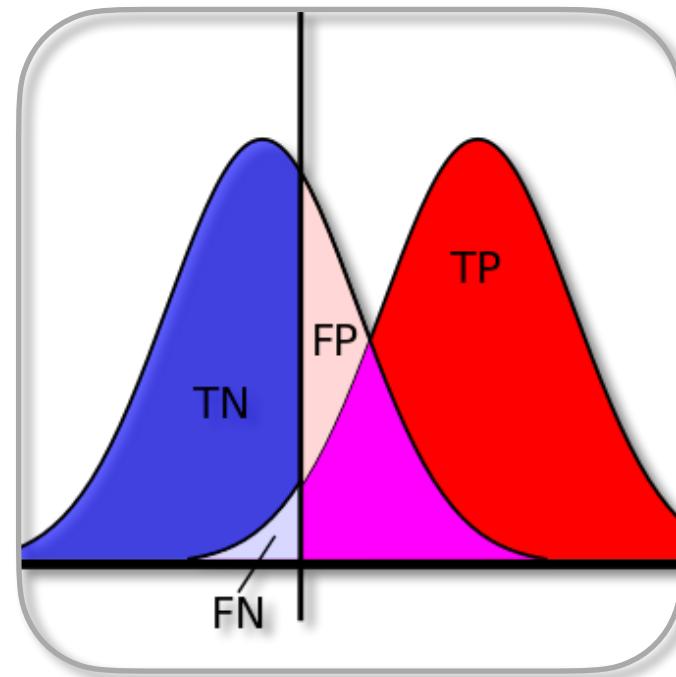


Today you will...

Get to know
Alternative traits and
Soft Biometrics.

Course Overview

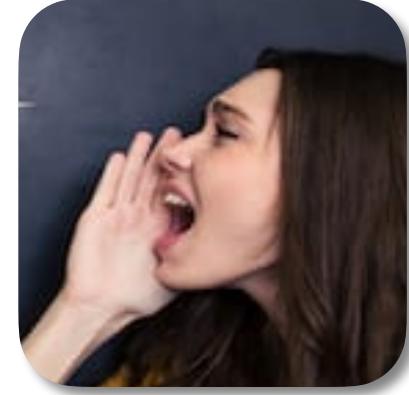
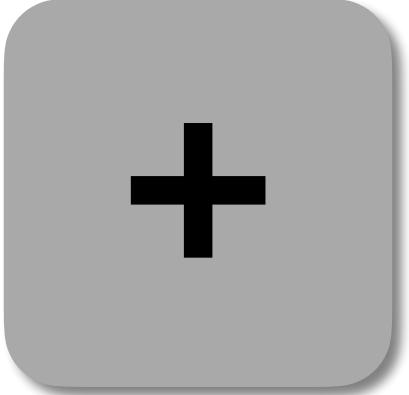
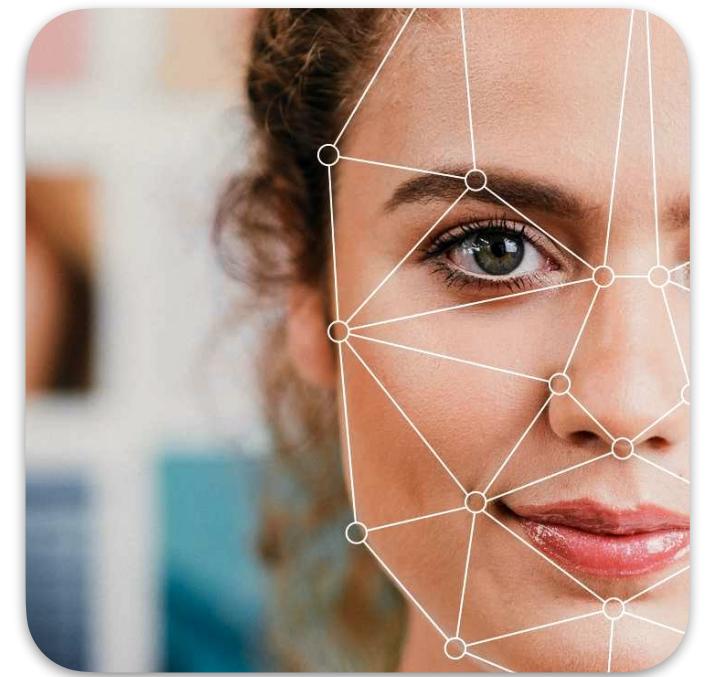
Content



Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
Evaluation
Assignments



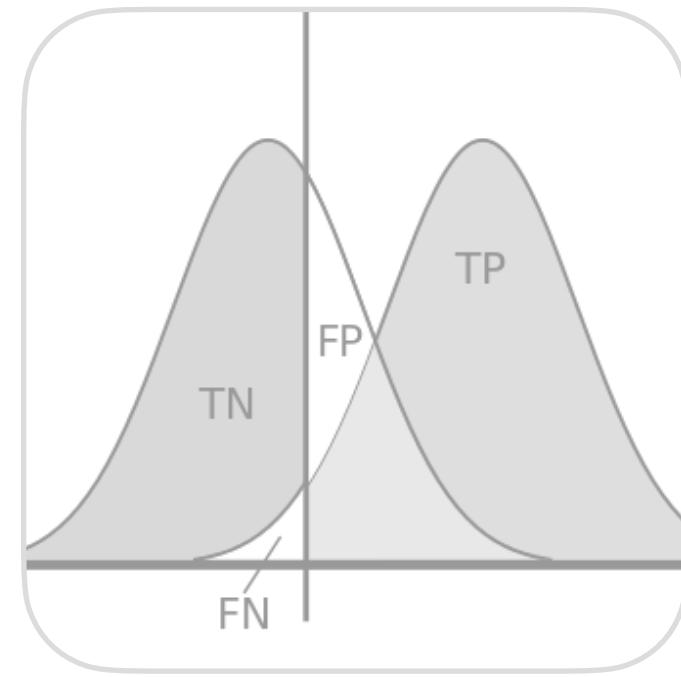
Alternative Traits and Fusion Concepts



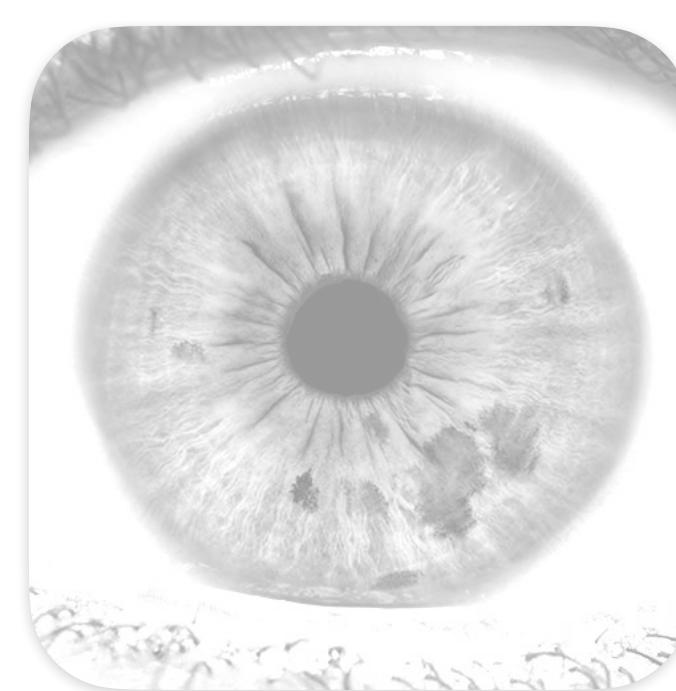
Invited Talks (2)
State of the art
Future work

Course Overview

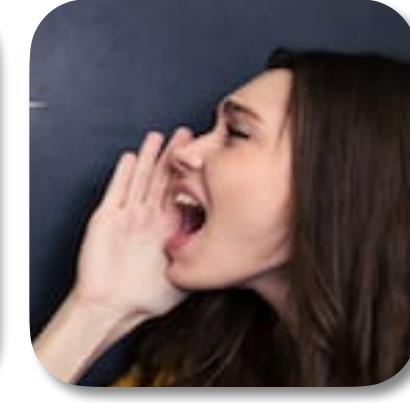
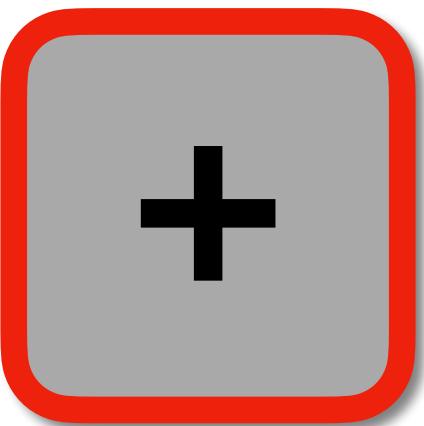
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Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
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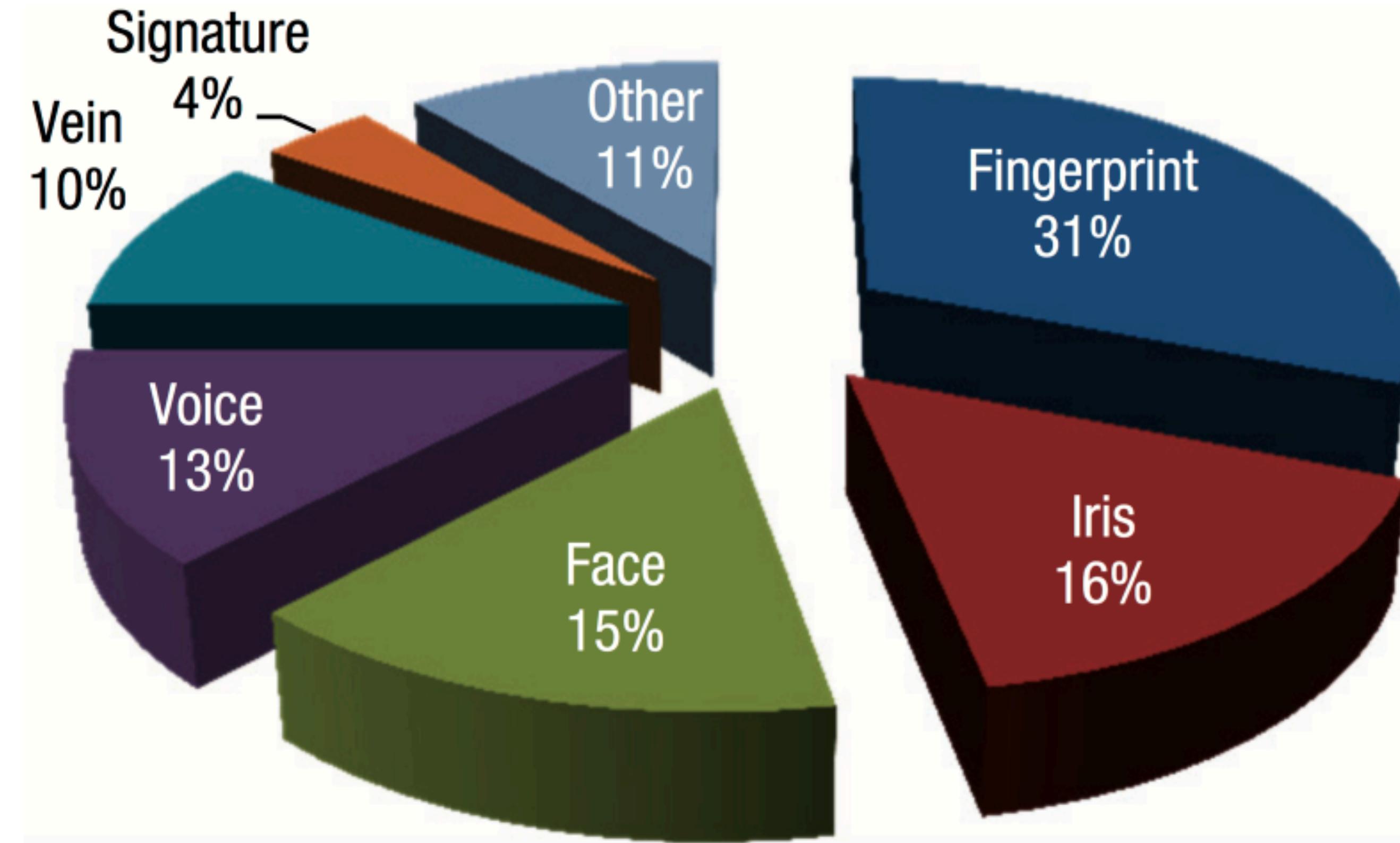
Alternative Traits and
Fusion
Concepts



Invited Talks (2)
State of the art
Future work

Alternative Traits

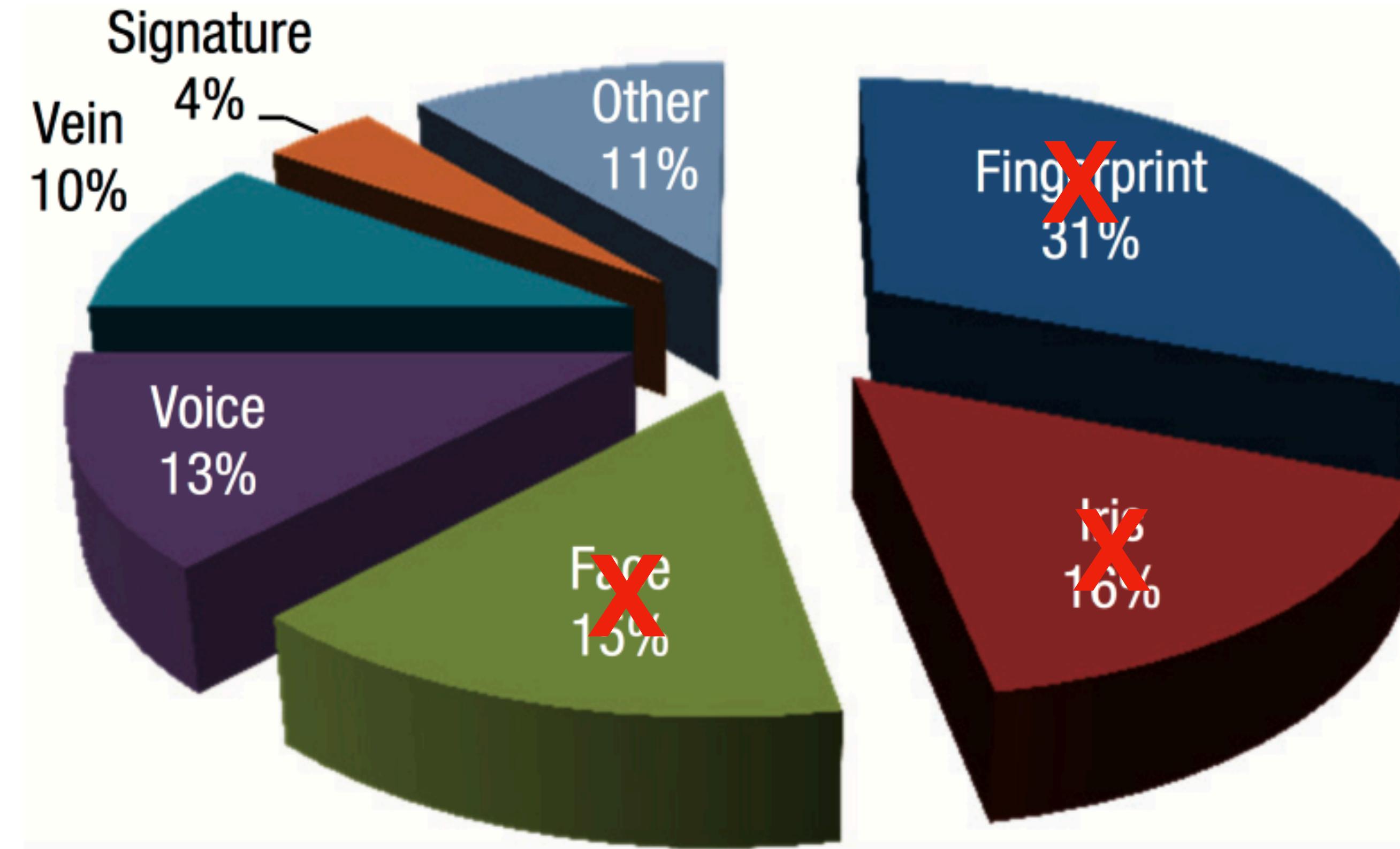
Market



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

Alternative Traits

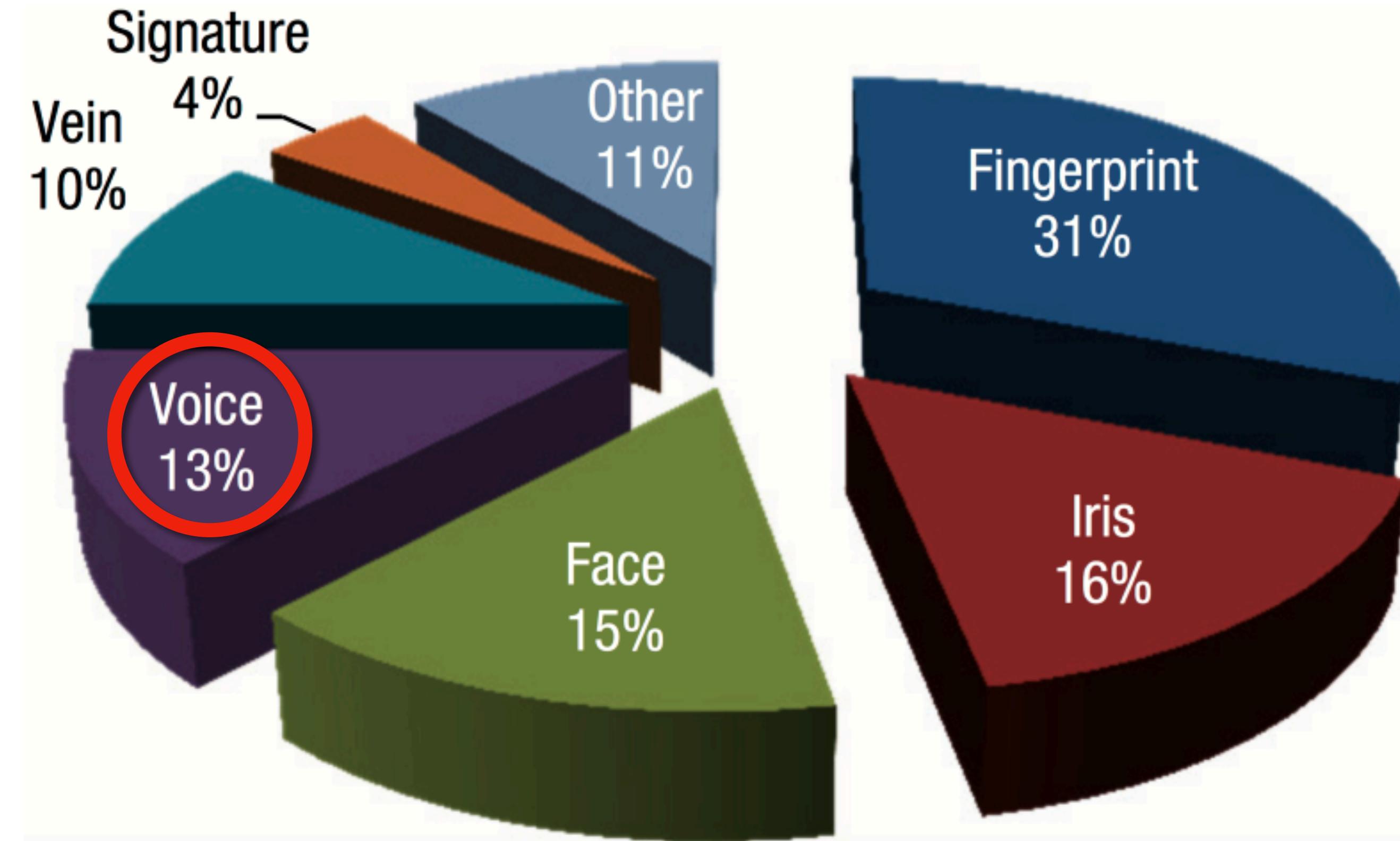
Market



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

Alternative Traits

Market



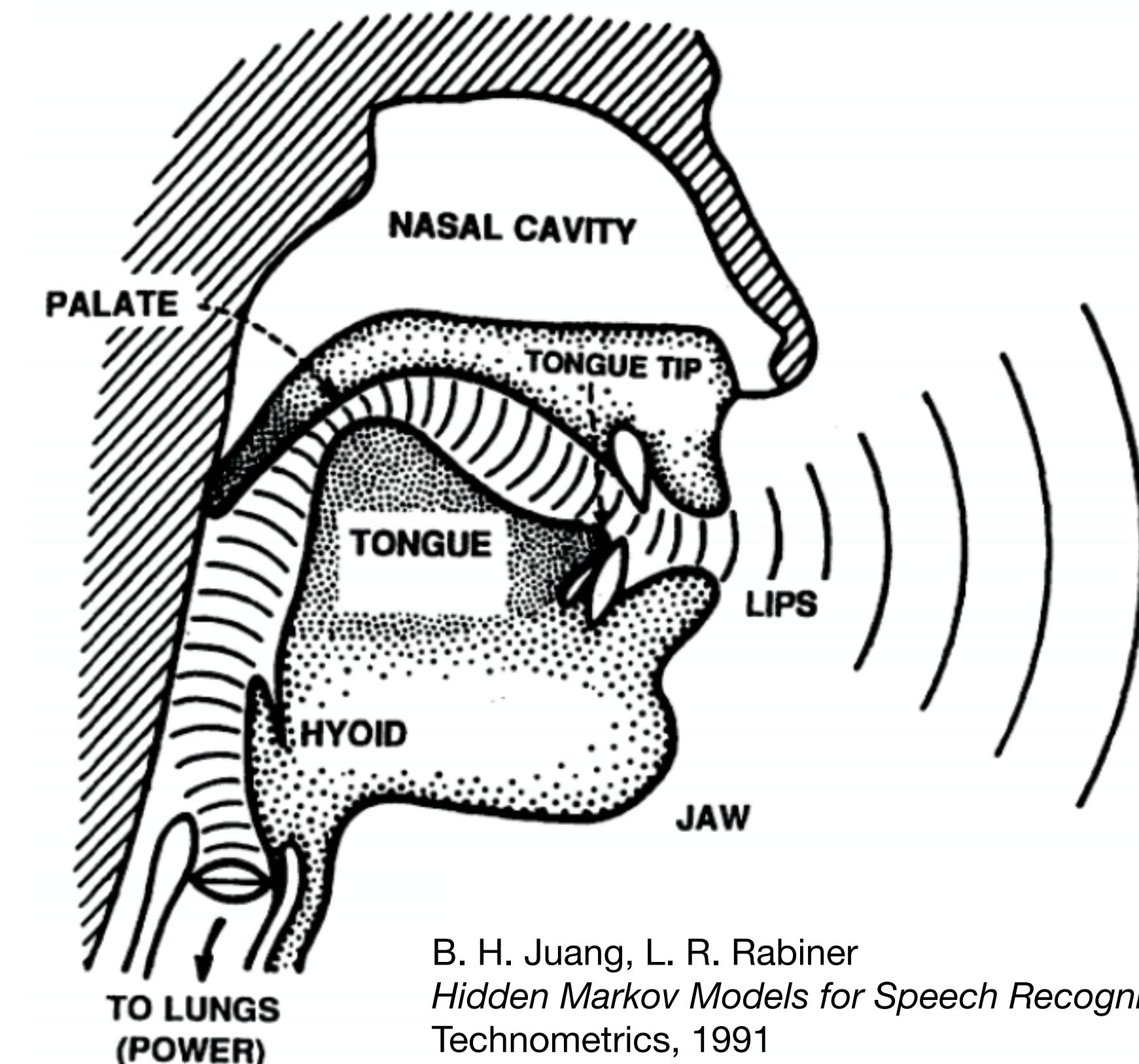
Source: Mani and Nadeski, *Processing solutions for biometric systems*, Texas Instruments, 2015

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

Voice Recognition

Acquisition

Off-line

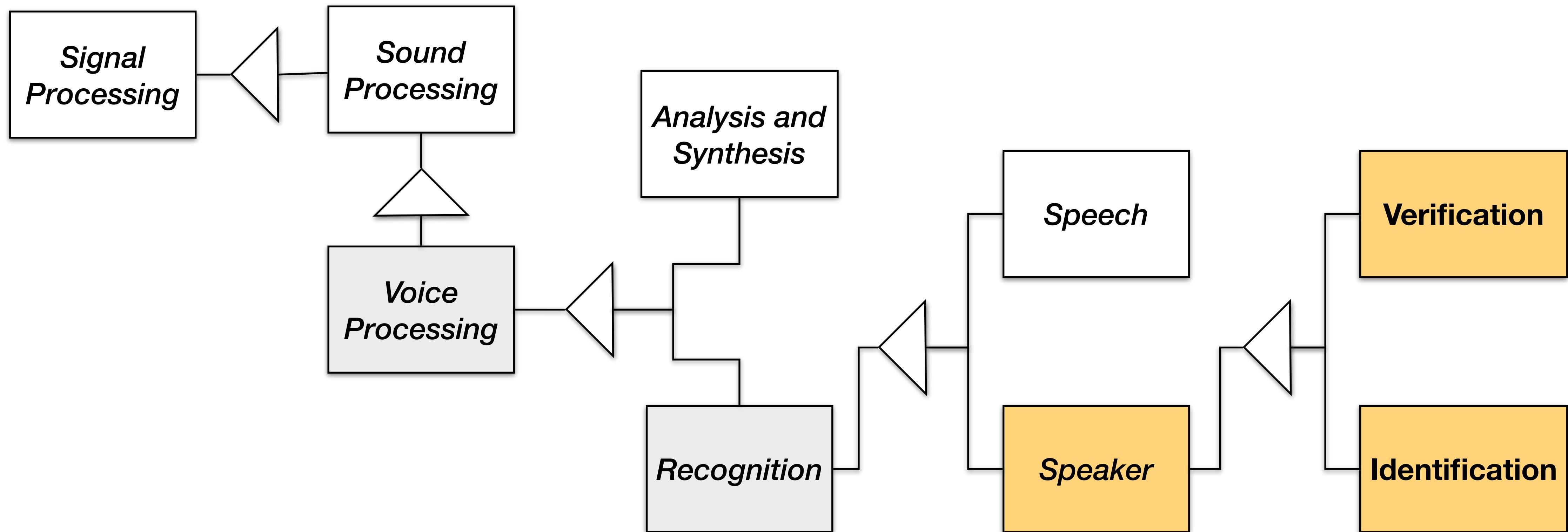


On-line



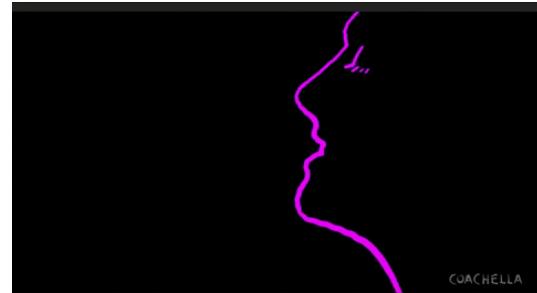
Voice Recognition

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

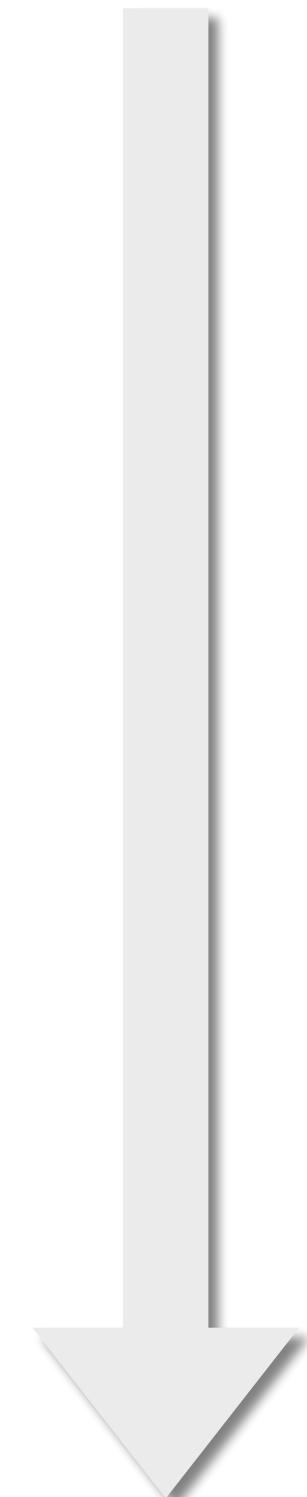
Users may say any word/phrase.

Conversational (under development)

Speech and speaker recognition,
with semantic analysis.

Security

increases



Voice Recognition

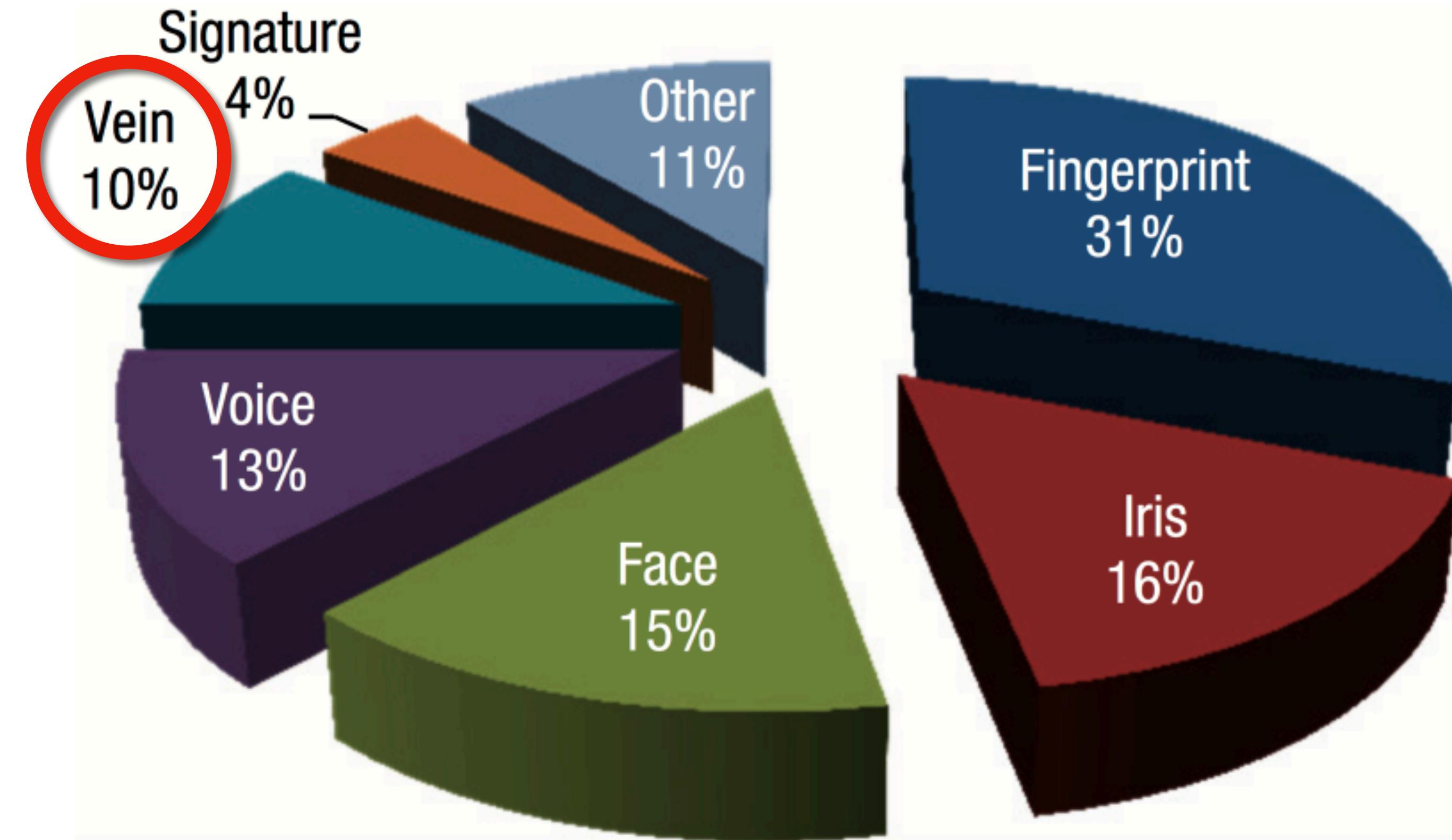
A New Era of Presentation Attack

The following audio clips are not real, they were generated by a machine learning model.

[https://www.youtube.com/
watch?v=DWK_iYBl8cA](https://www.youtube.com/watch?v=DWK_iYBl8cA)

Alternative Traits

Market



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.



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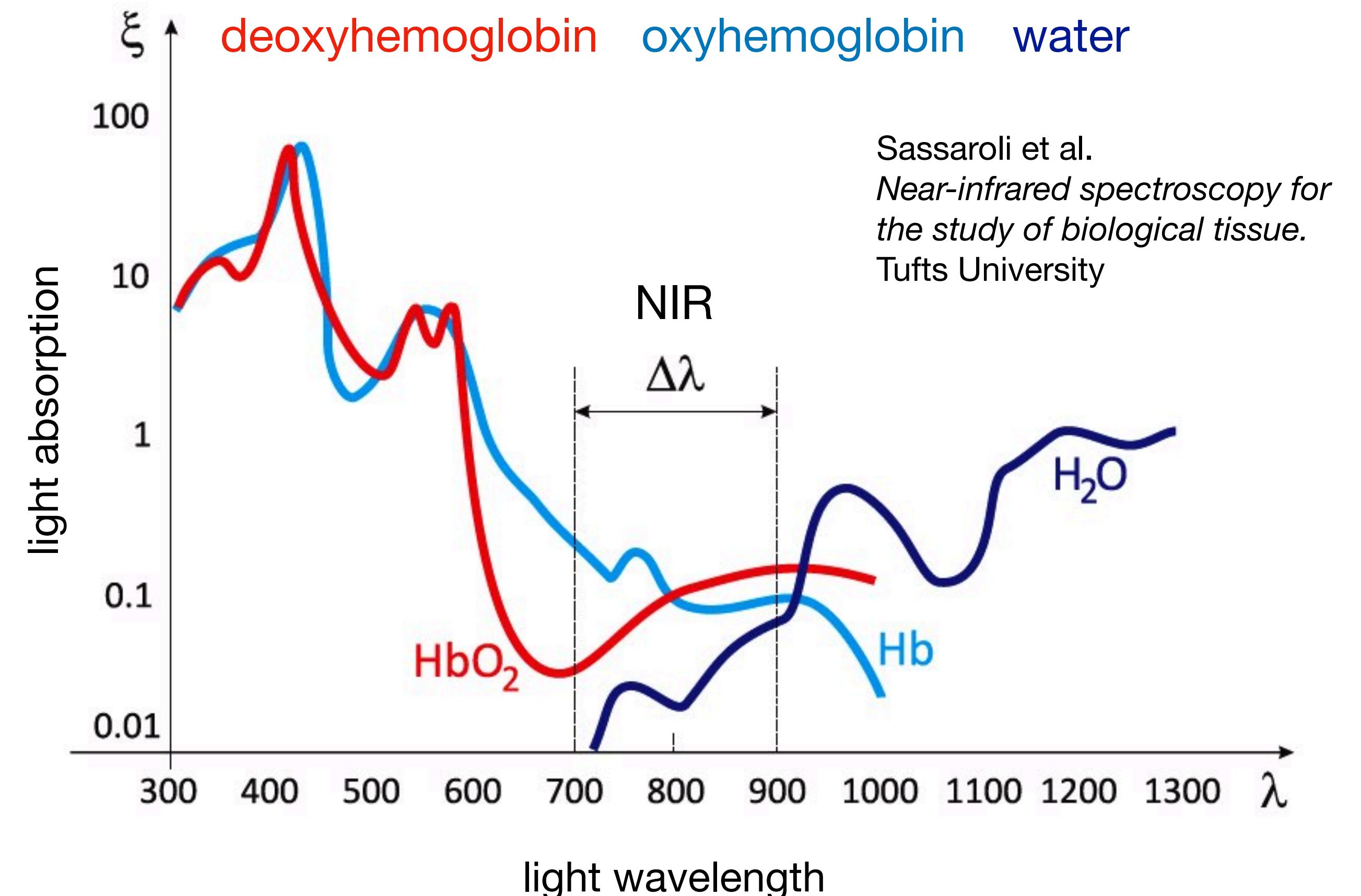


Hitachi
Finger Vein Authentication
White Paper, 2004

Vein Recognition

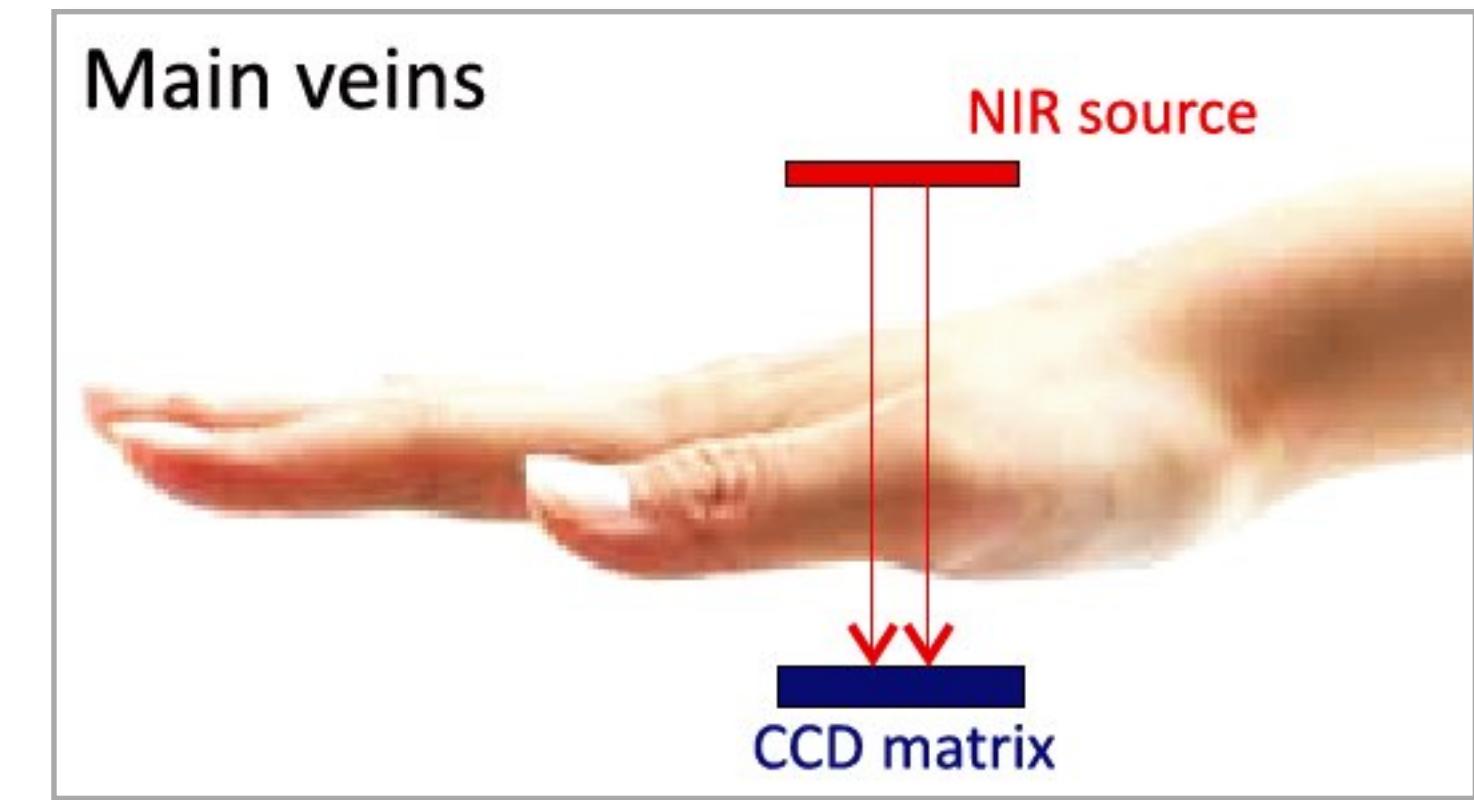
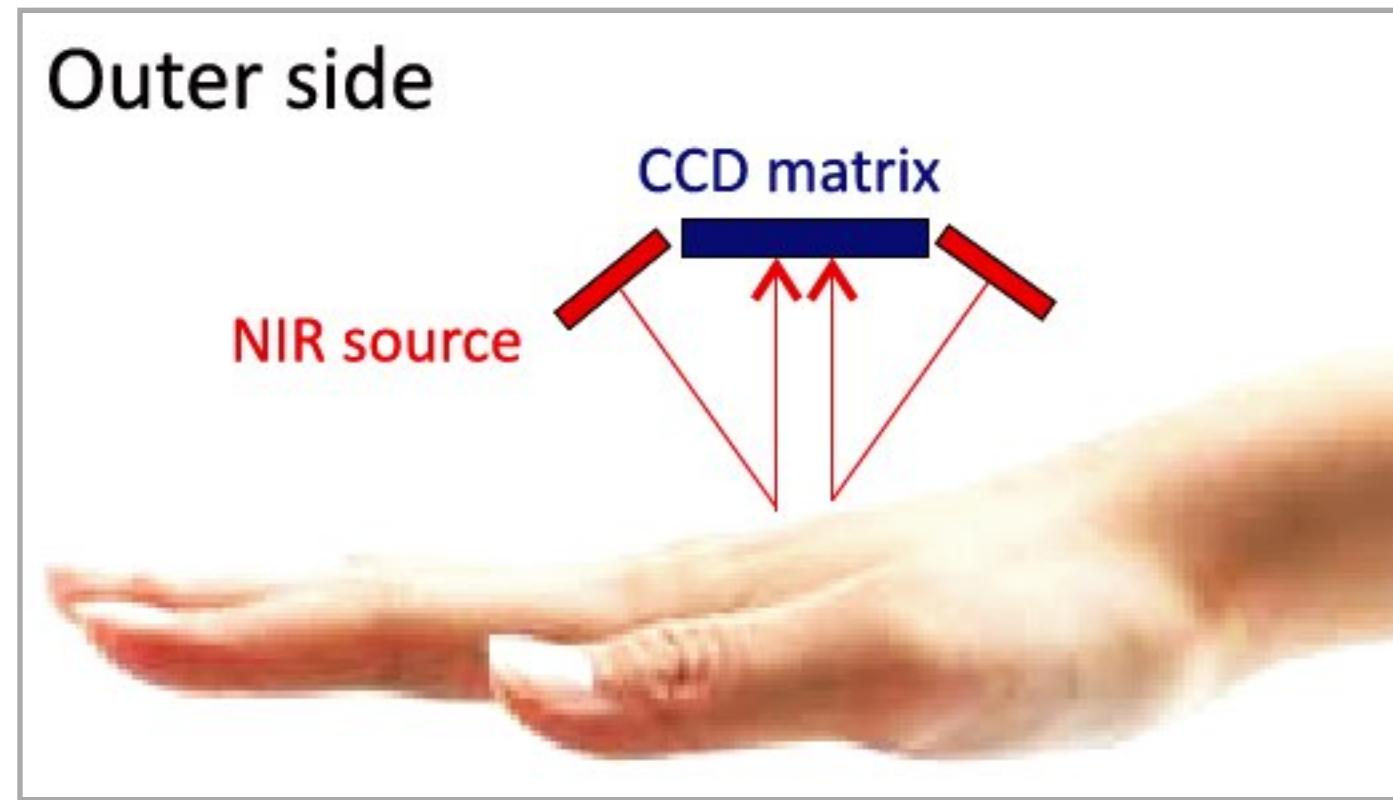
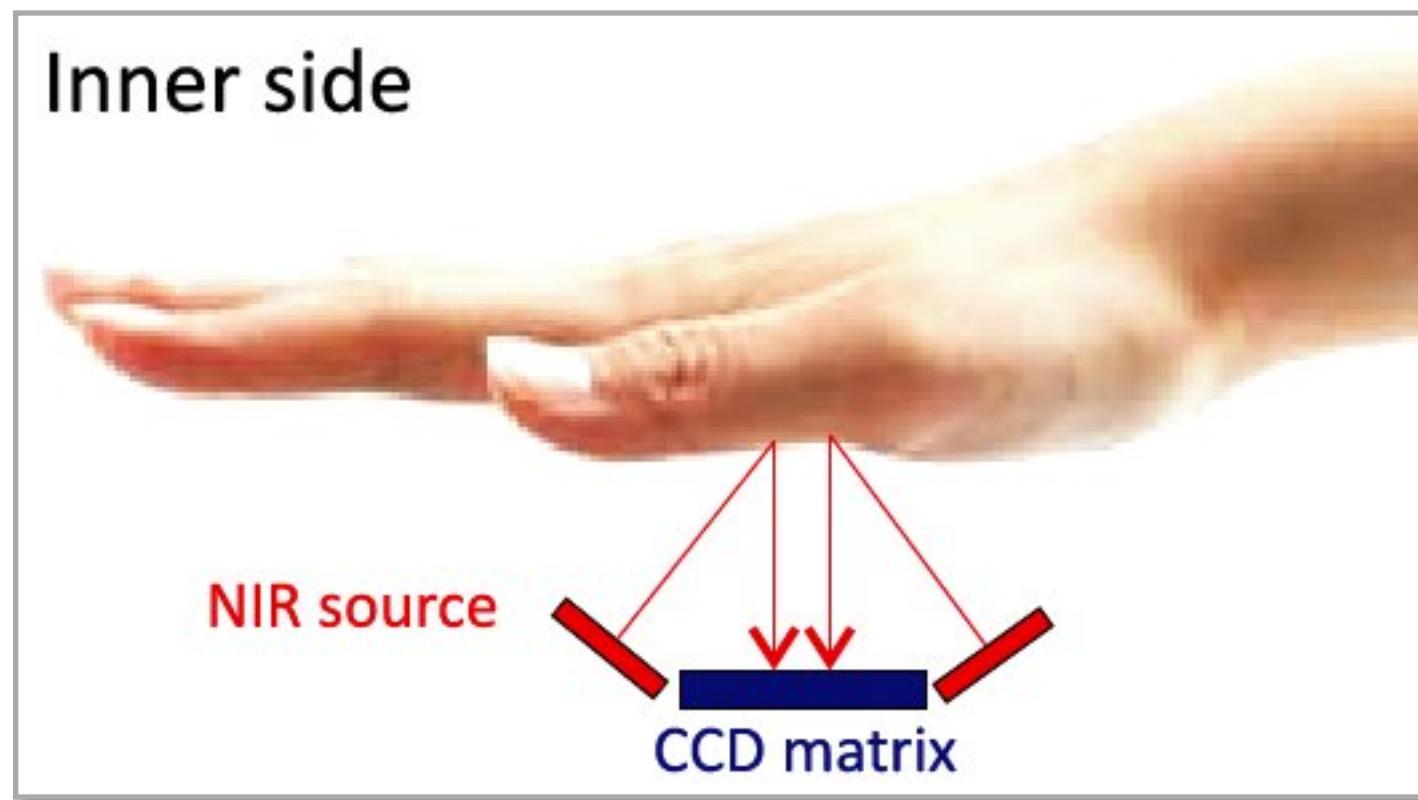
Acquisition

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



Vein Recognition

Palm Vein Acquisition



Dr. Adam Czajka

Vein Recognition

Palm Vein Acquisition



Fujitsu PalmSecure reader



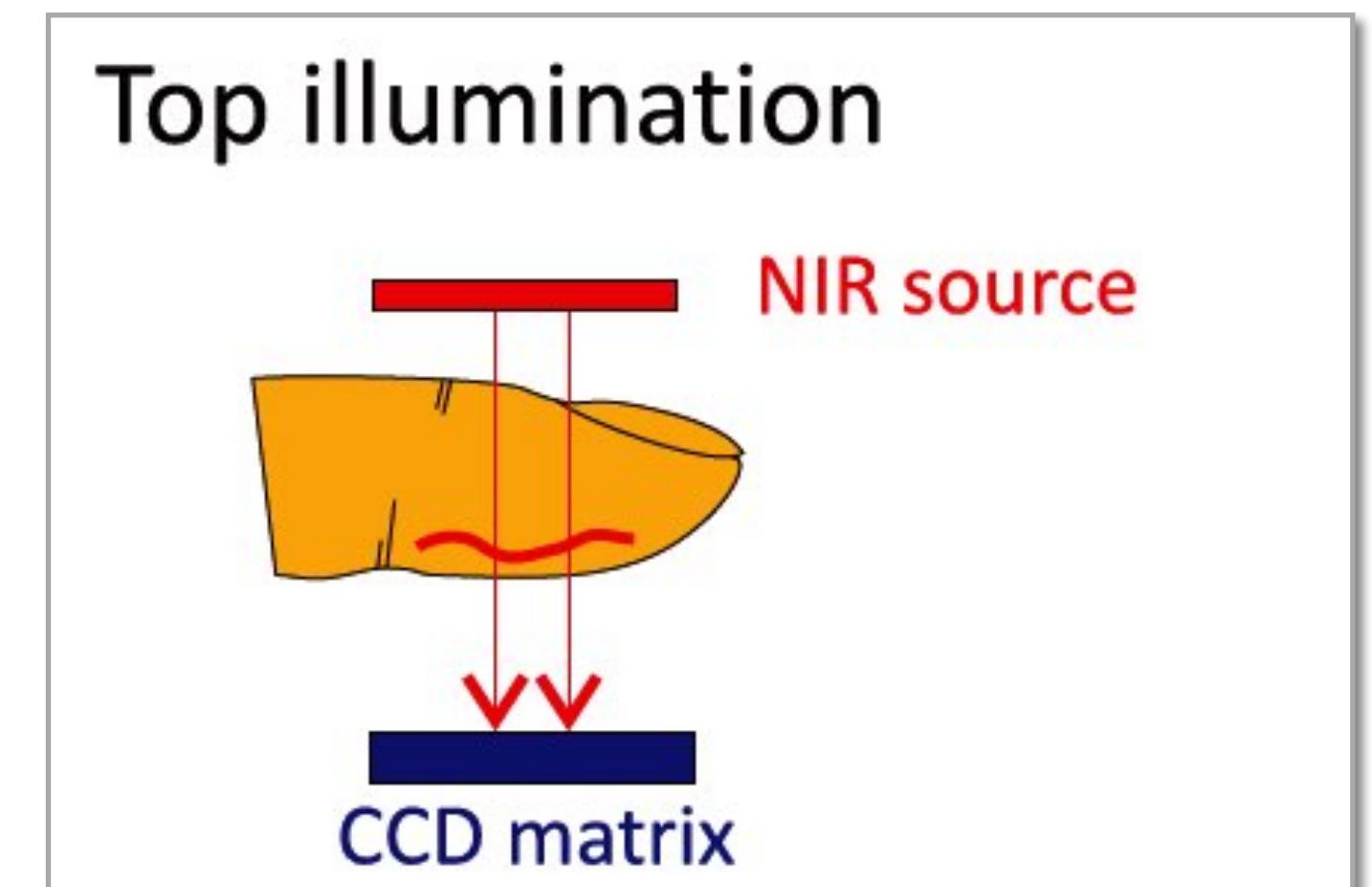
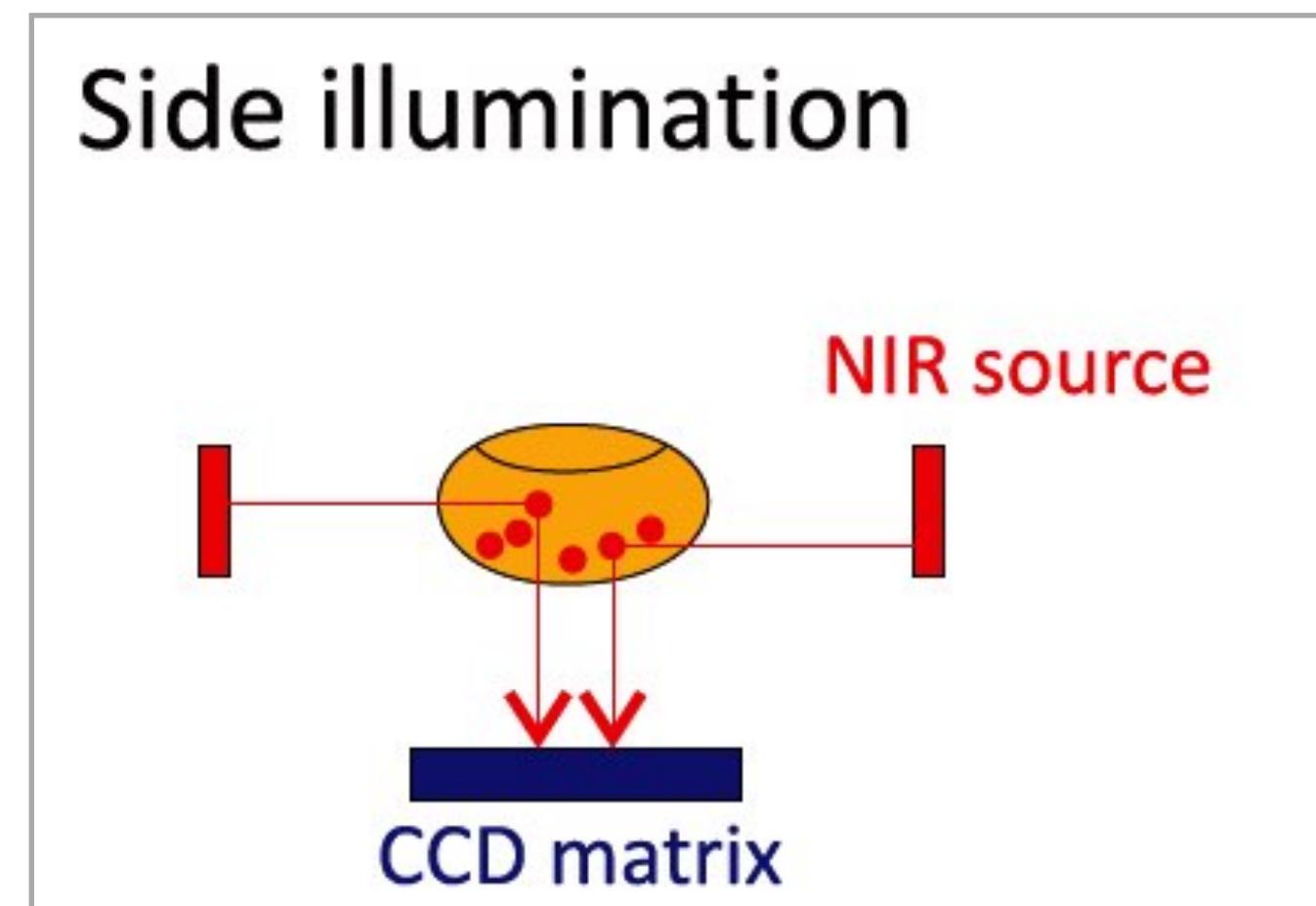
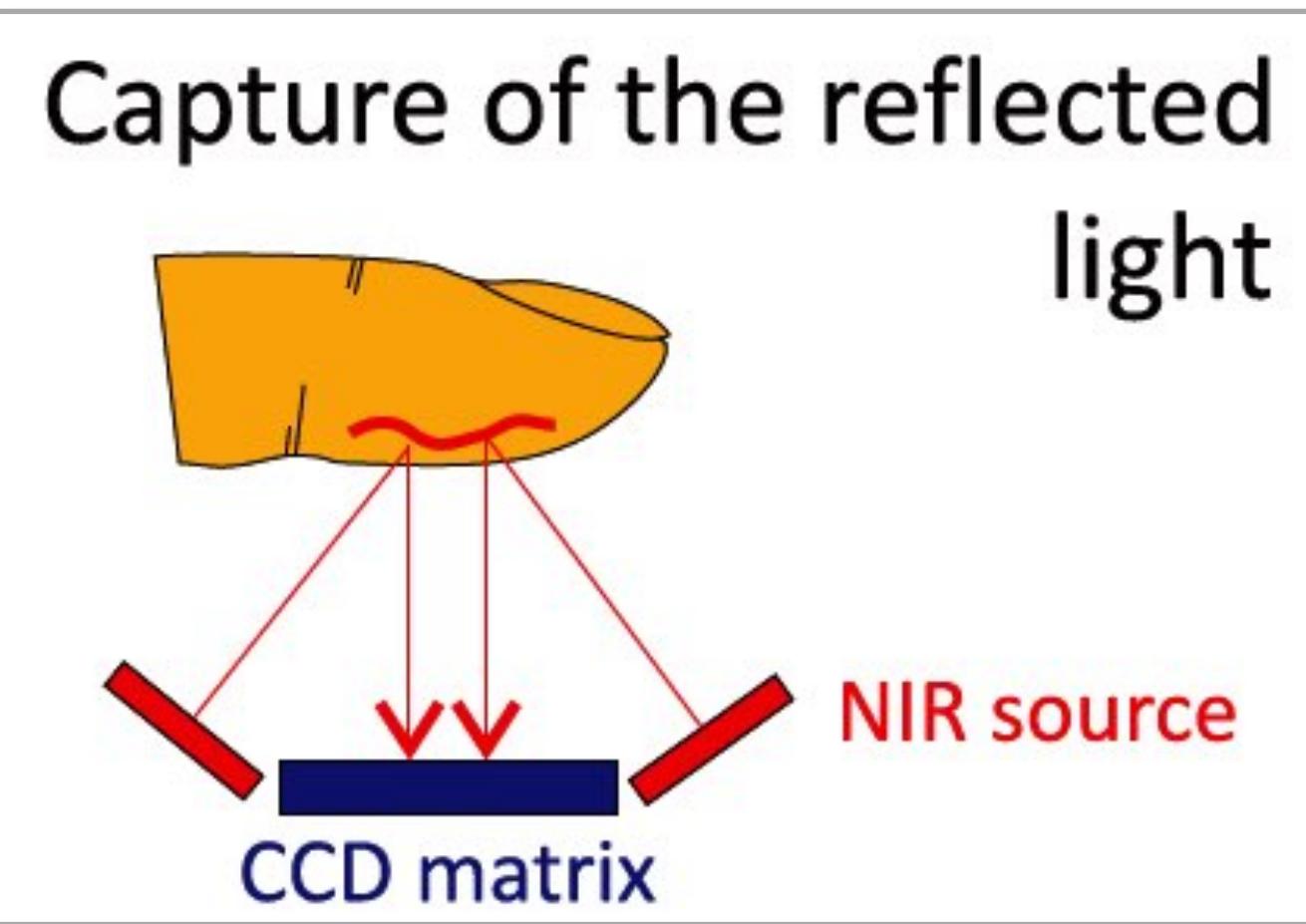
Techsphere VP II reader

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



Vein Recognition

Finger Vein Acquisition



Dr. Adam Czajka

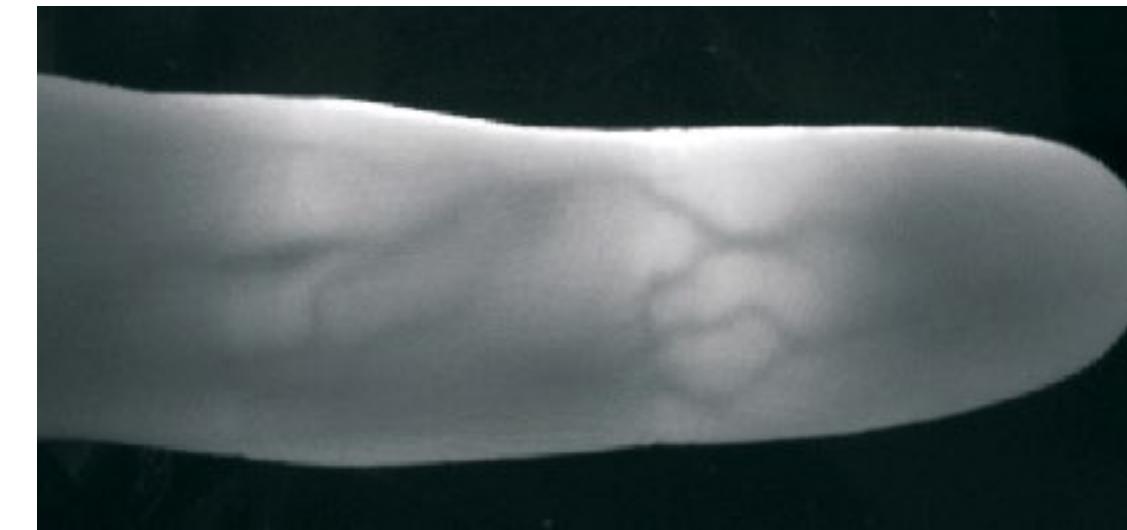
Vein Recognition

Finger Vein Acquisition



Hitachi H1 reader
(with top illumination)

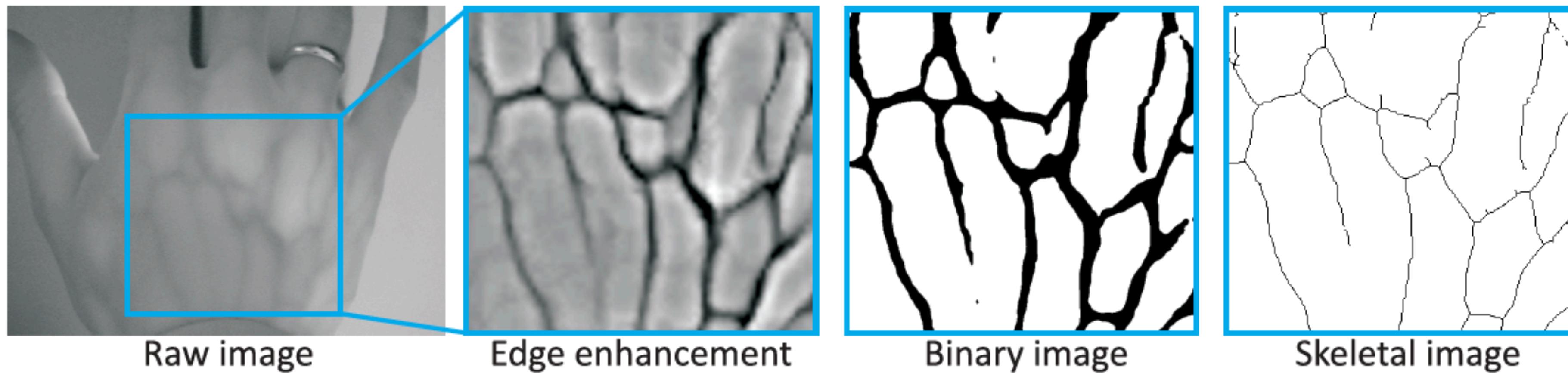
MITRE
State of the Art Biometrics Excellence Roadmap
Tech. Report, 2008



Vein Recognition

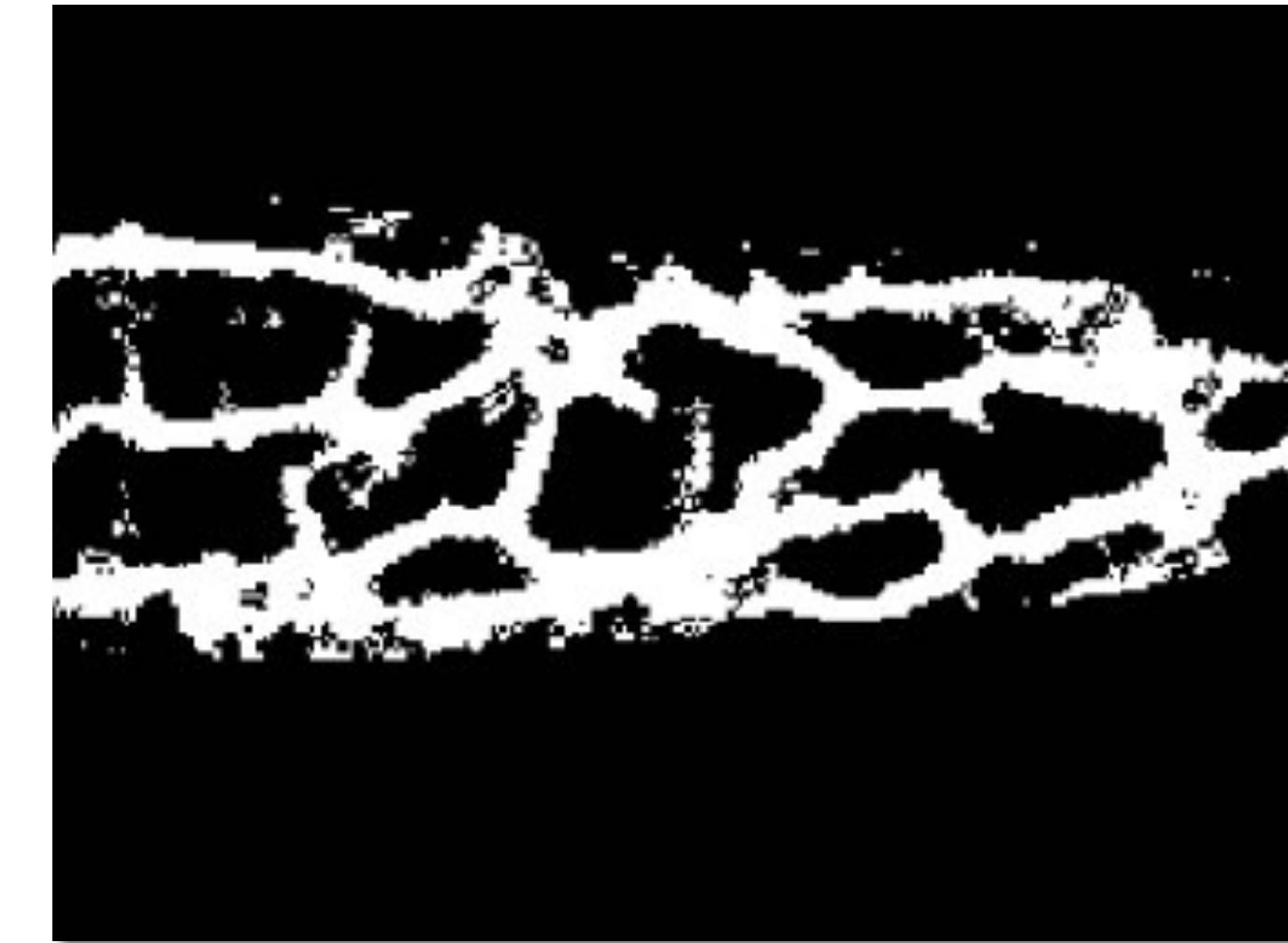
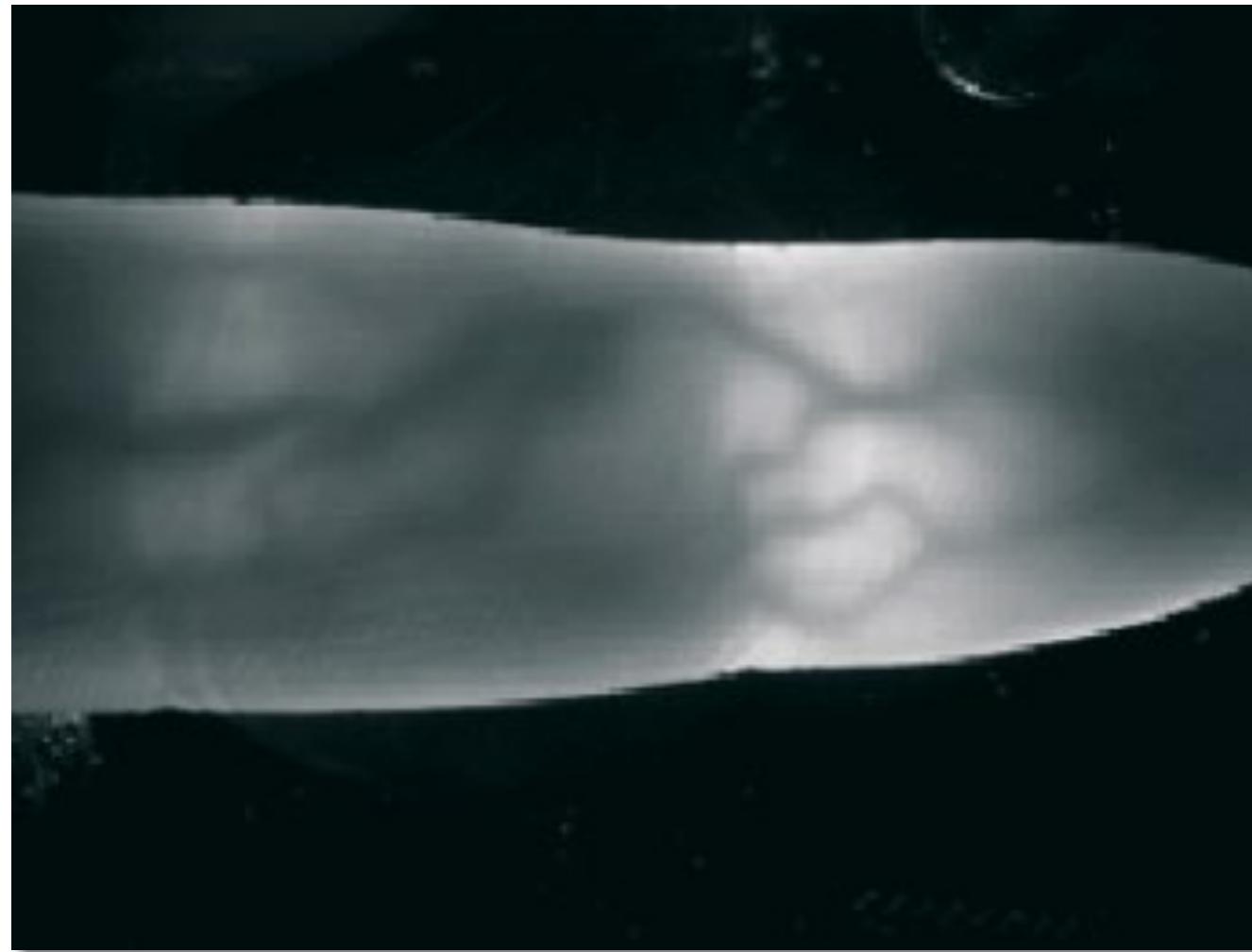
Vein Description Strategies

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Vein Recognition

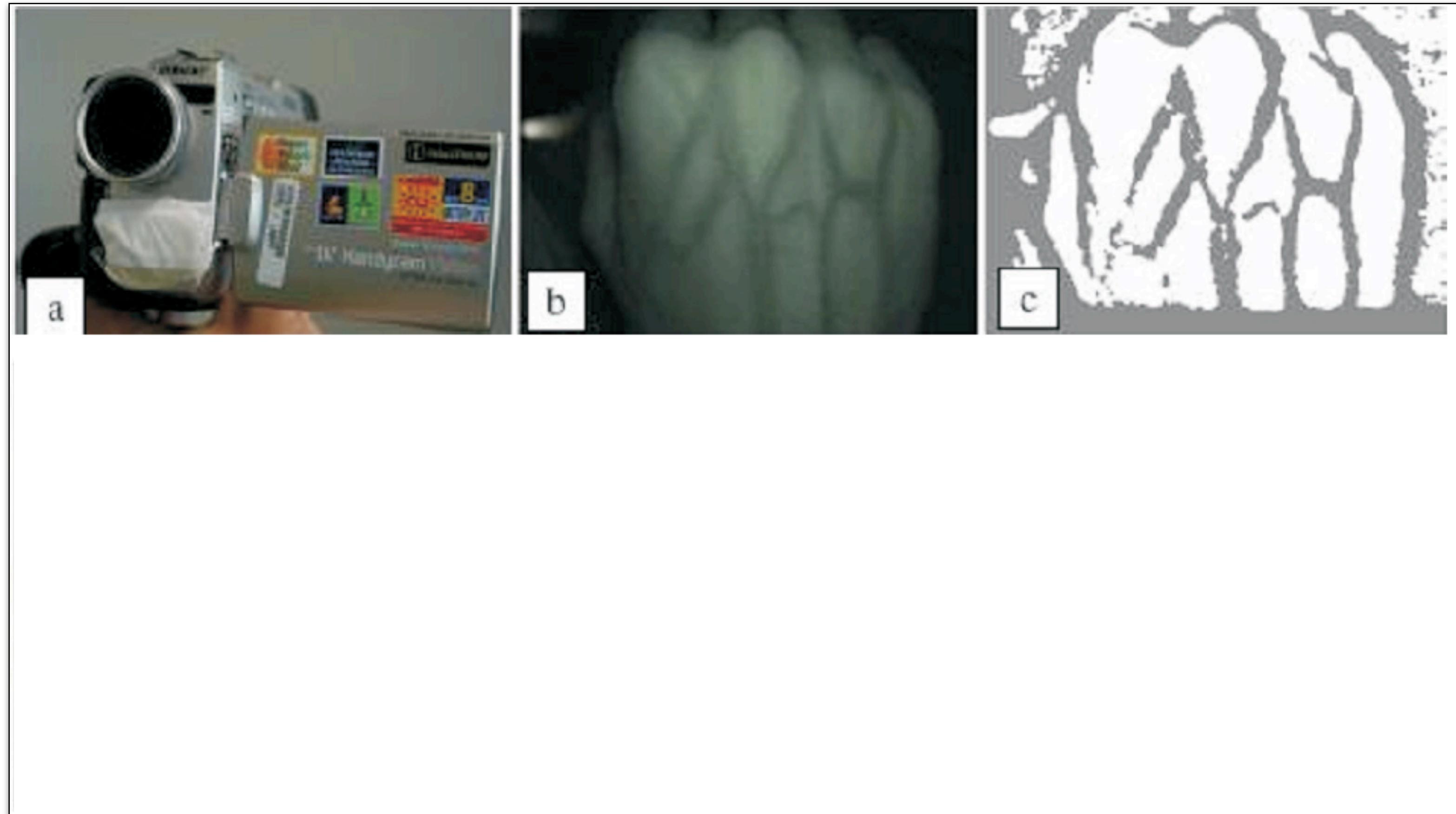
Vein Description Strategies



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

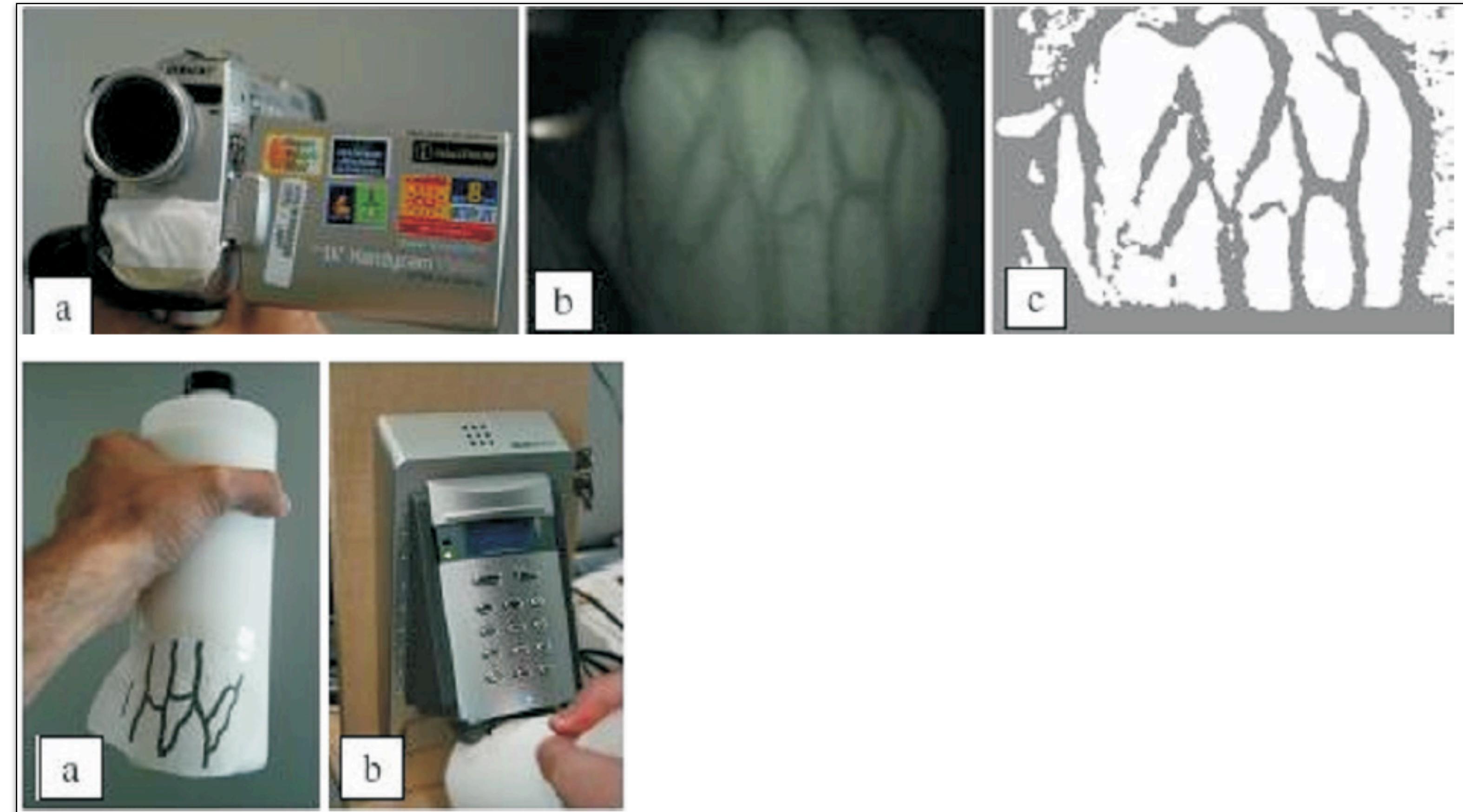
Vein Recognition

Presentation Attack



Vein Recognition

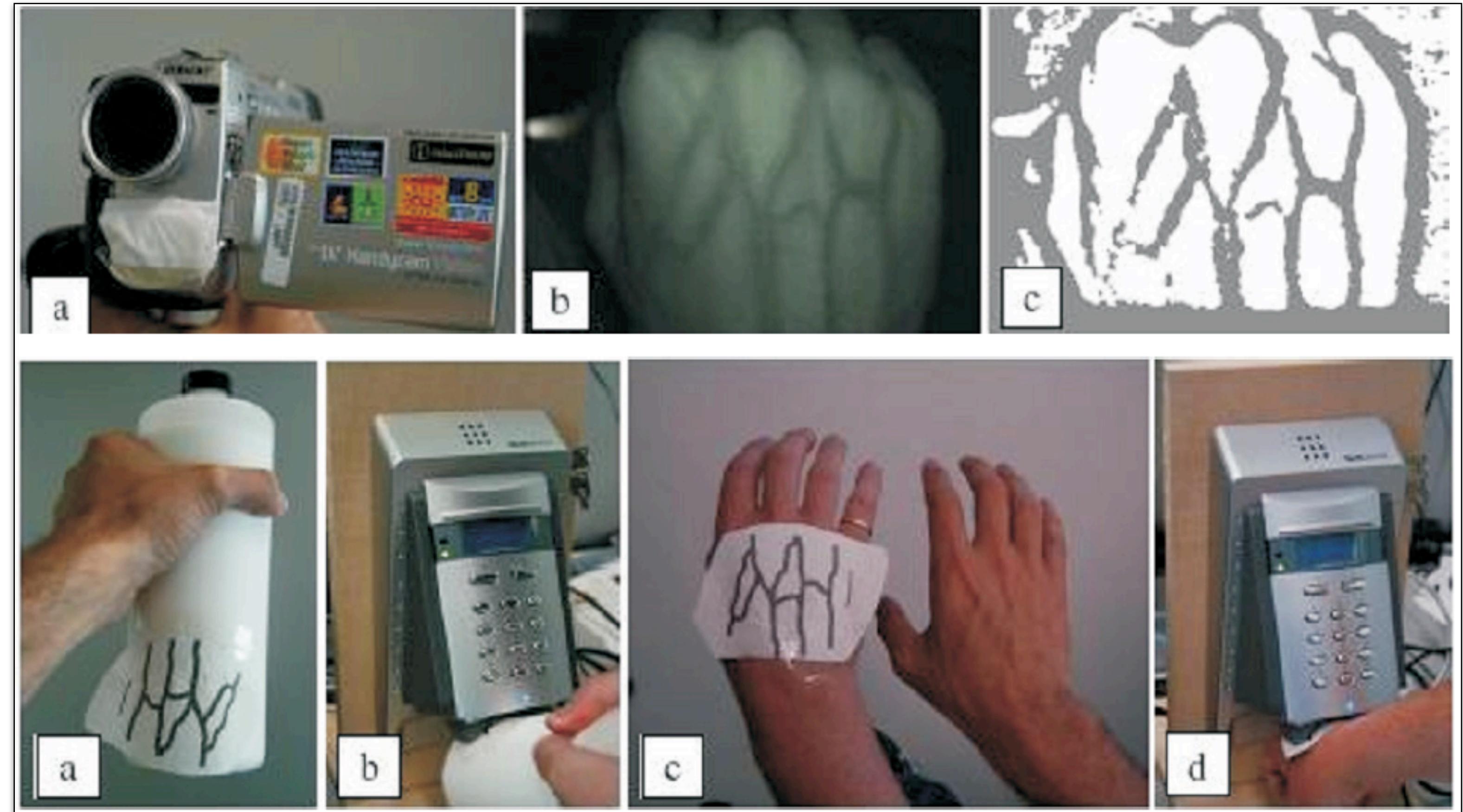
Presentation Attack



Vein Recognition

Presentation Attack

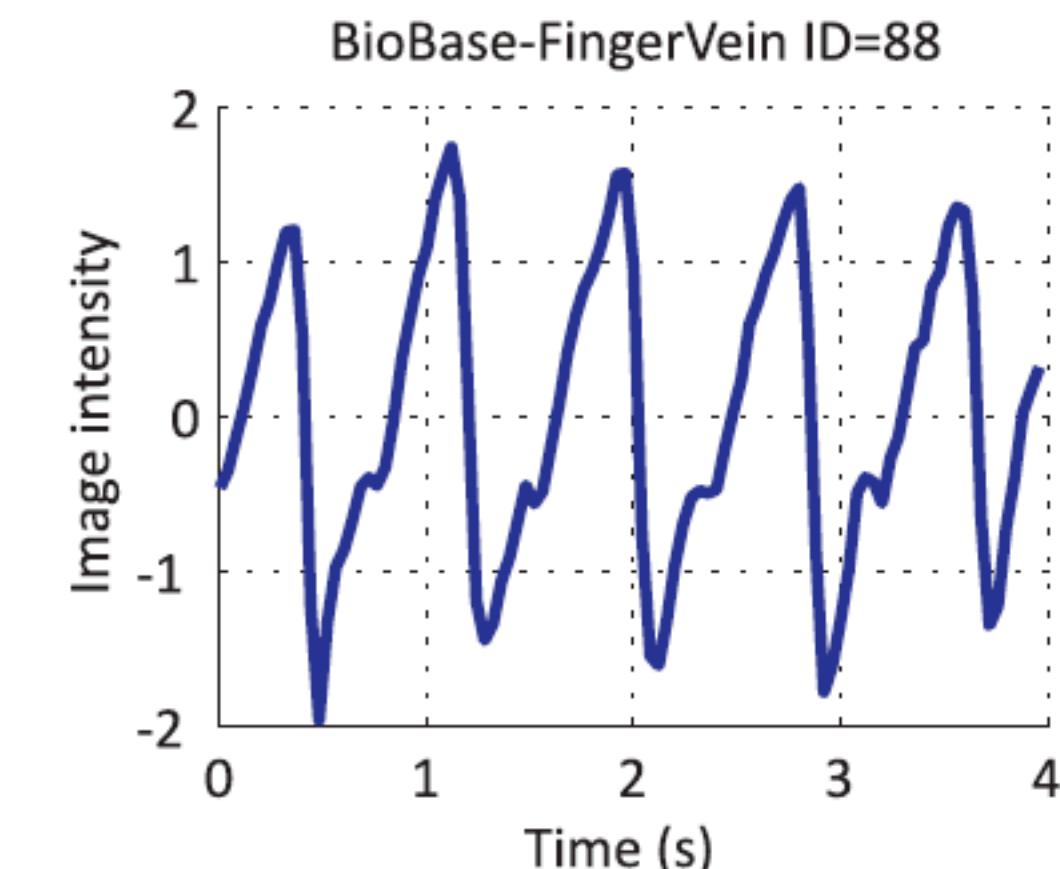
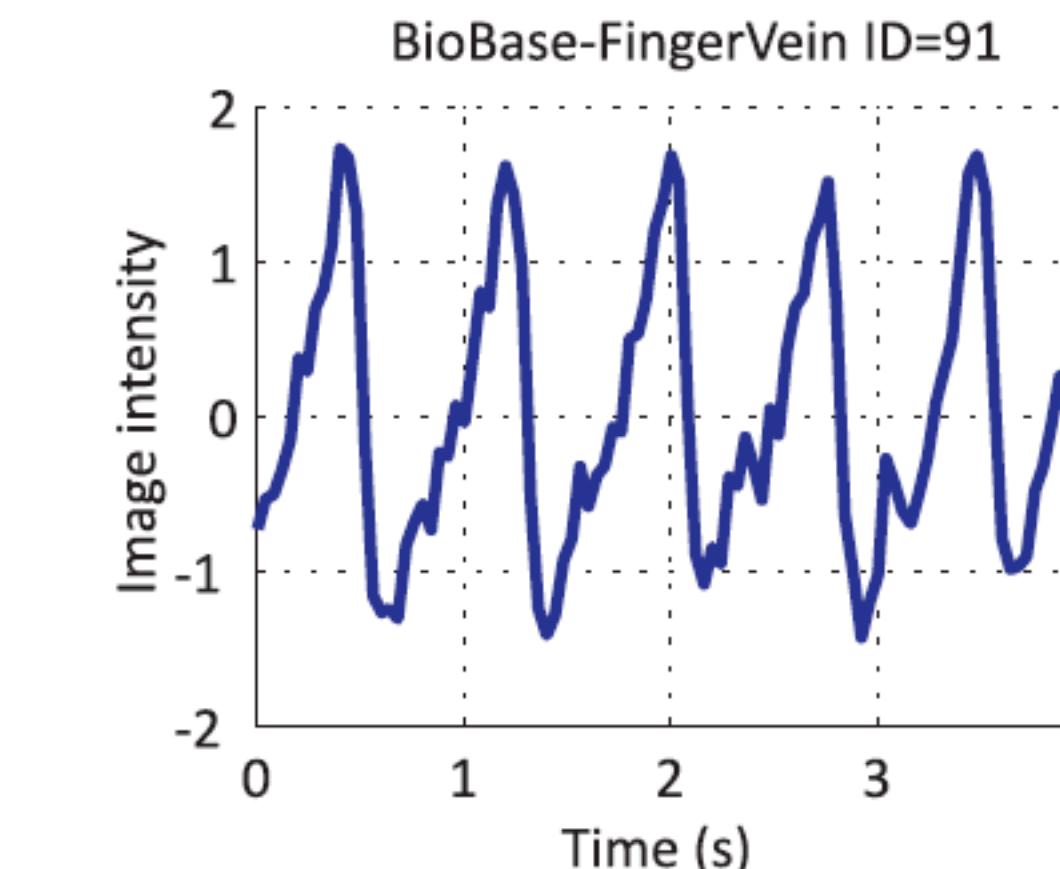
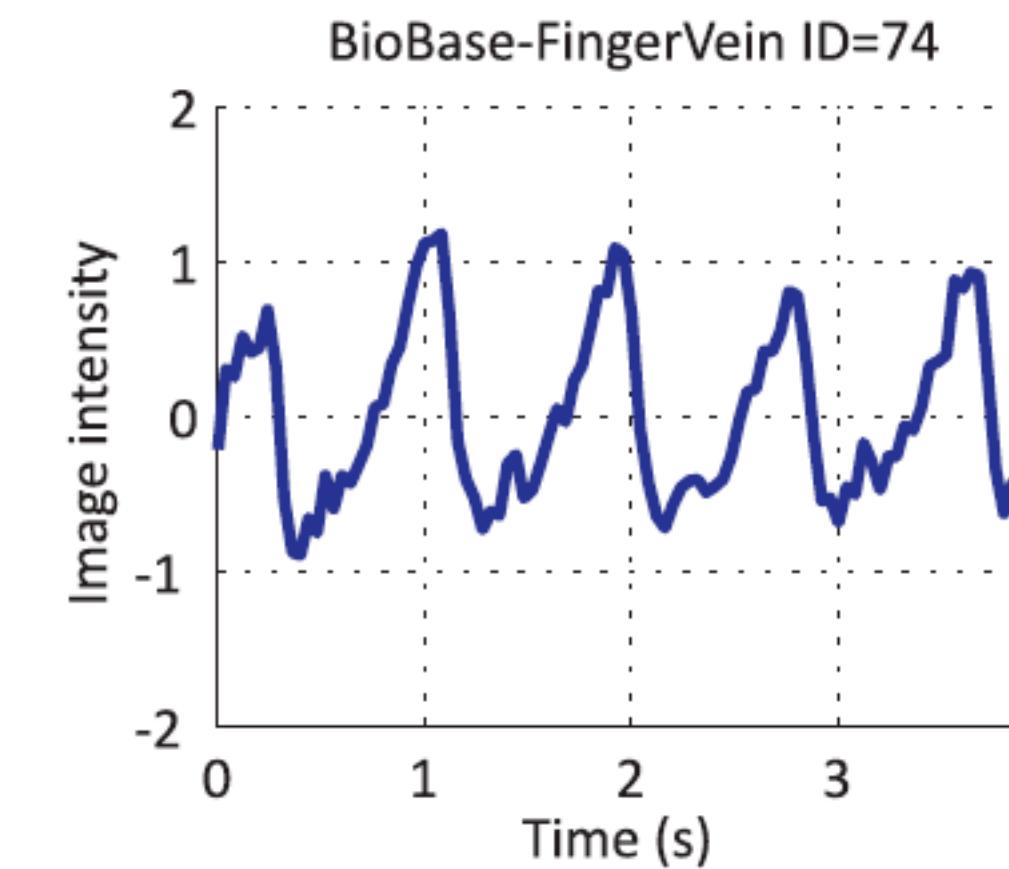
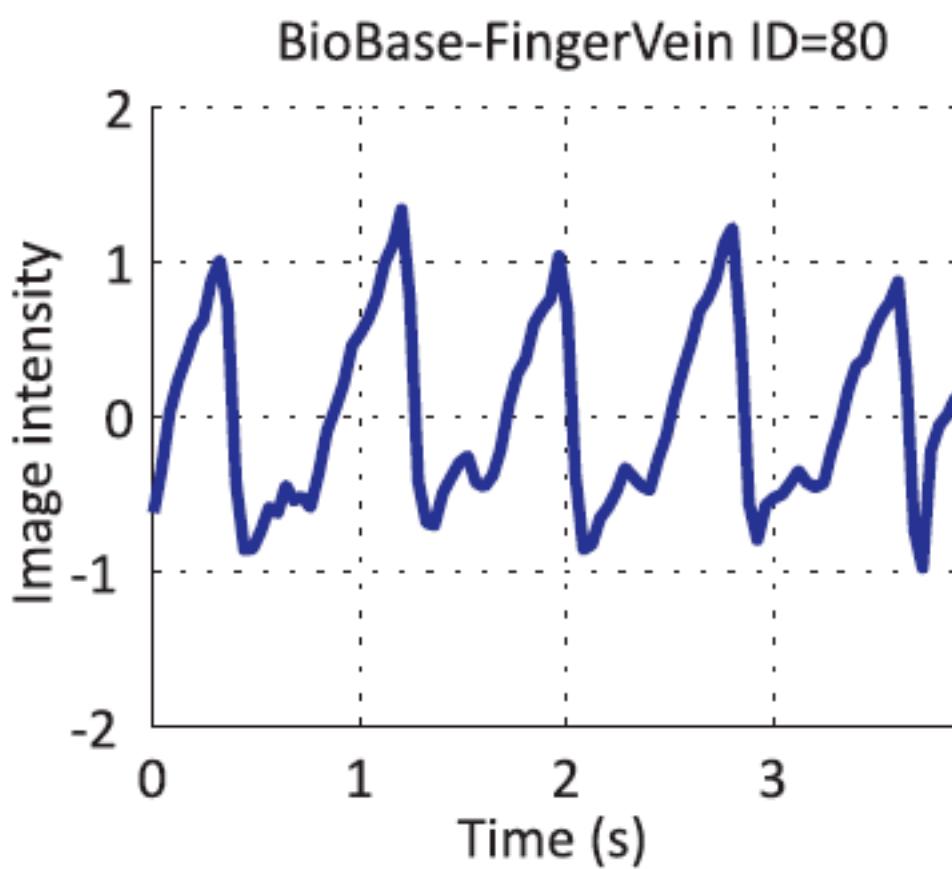
MITRE
State of the Art Biometrics Excellence Roadmap
Tech. Report, 2008



Vein Recognition

Presentation Attack Detection

Blood Pulse Detection

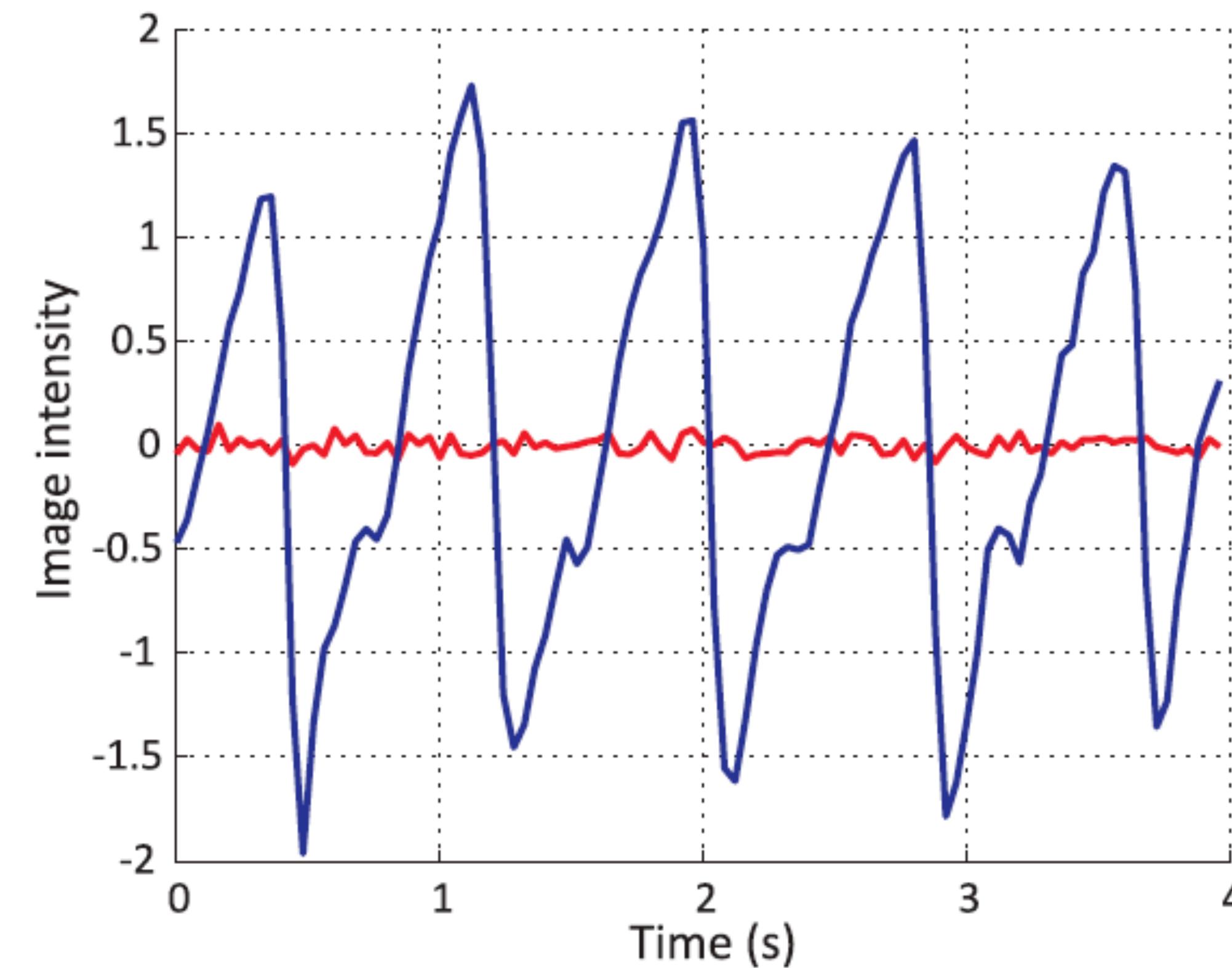


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Vein Recognition

Presentation Attack Detection

Blood Pulse Detection



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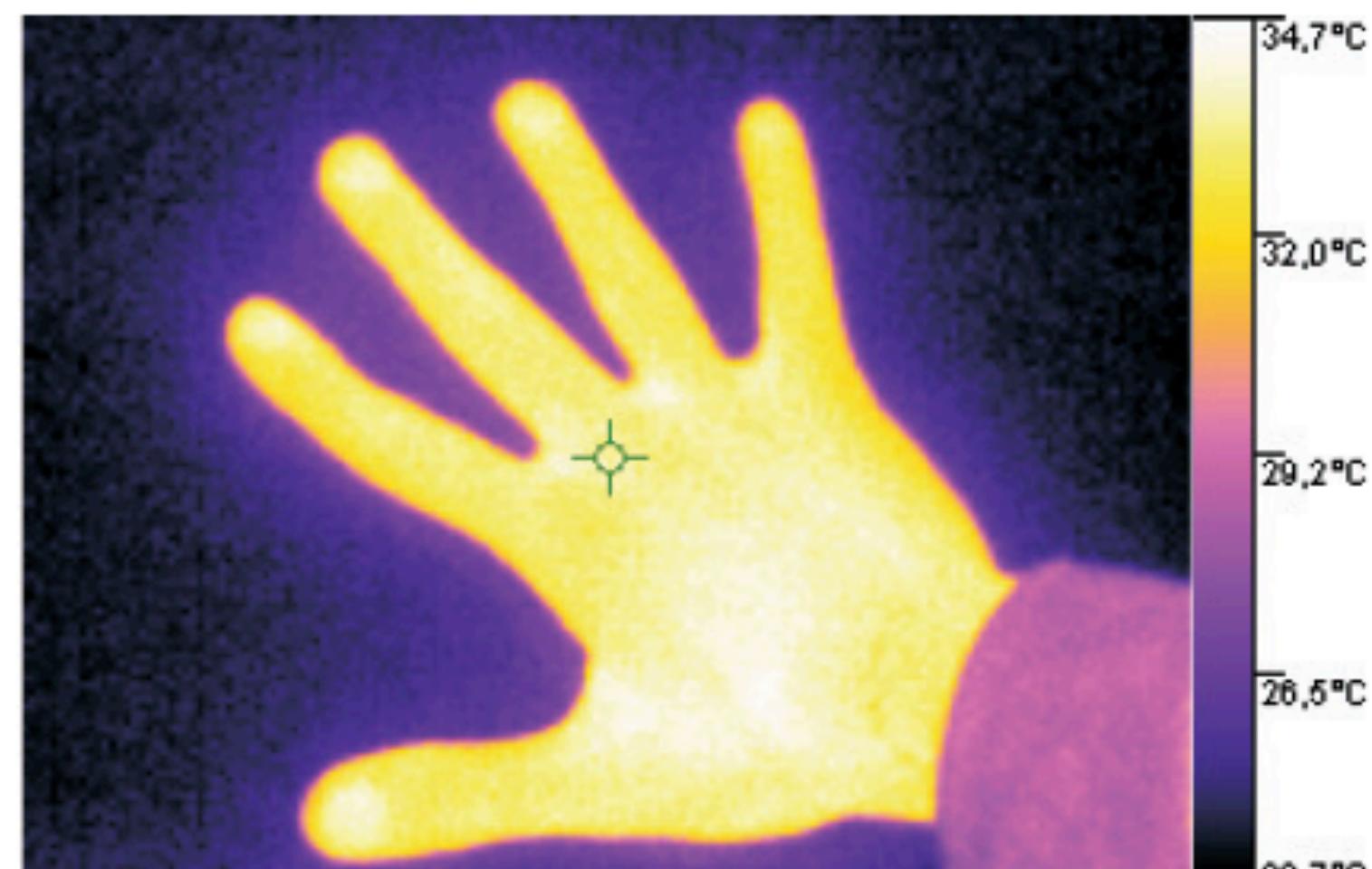
Forgery

Vein Recognition

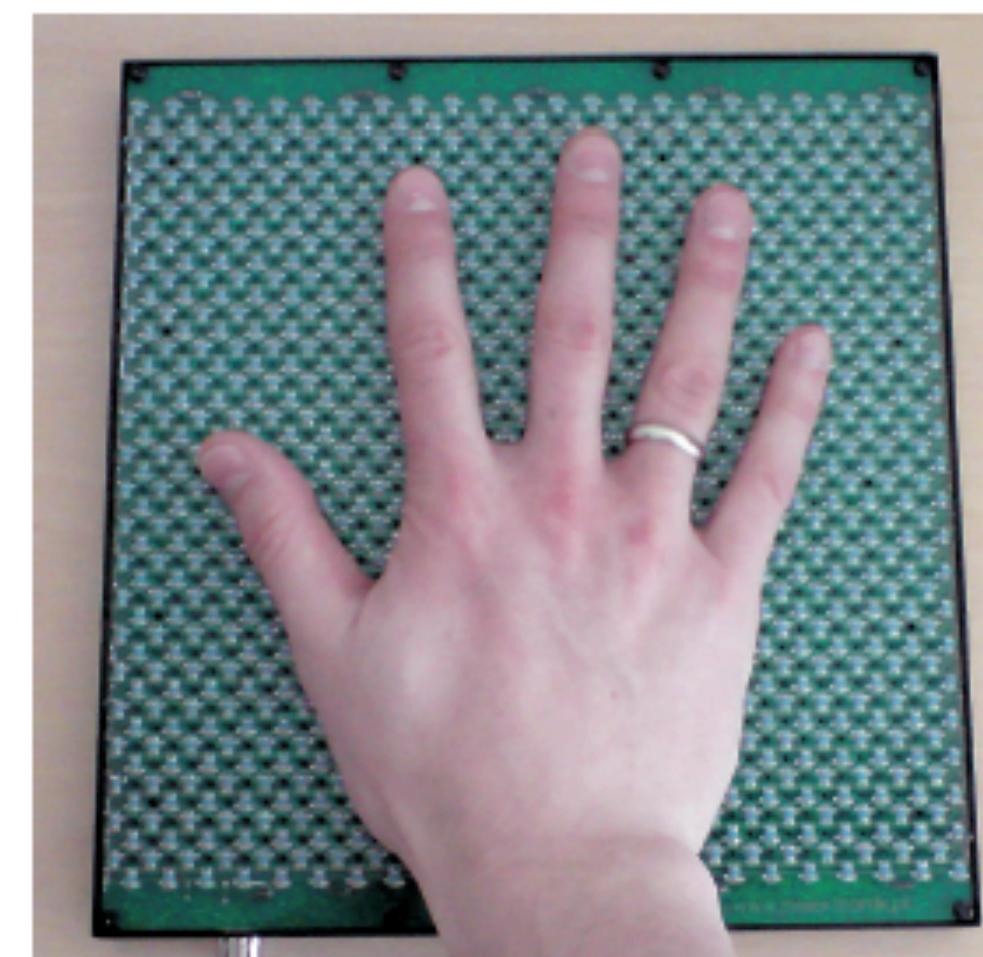
Presentation Attack Detection

Temperature Measurement

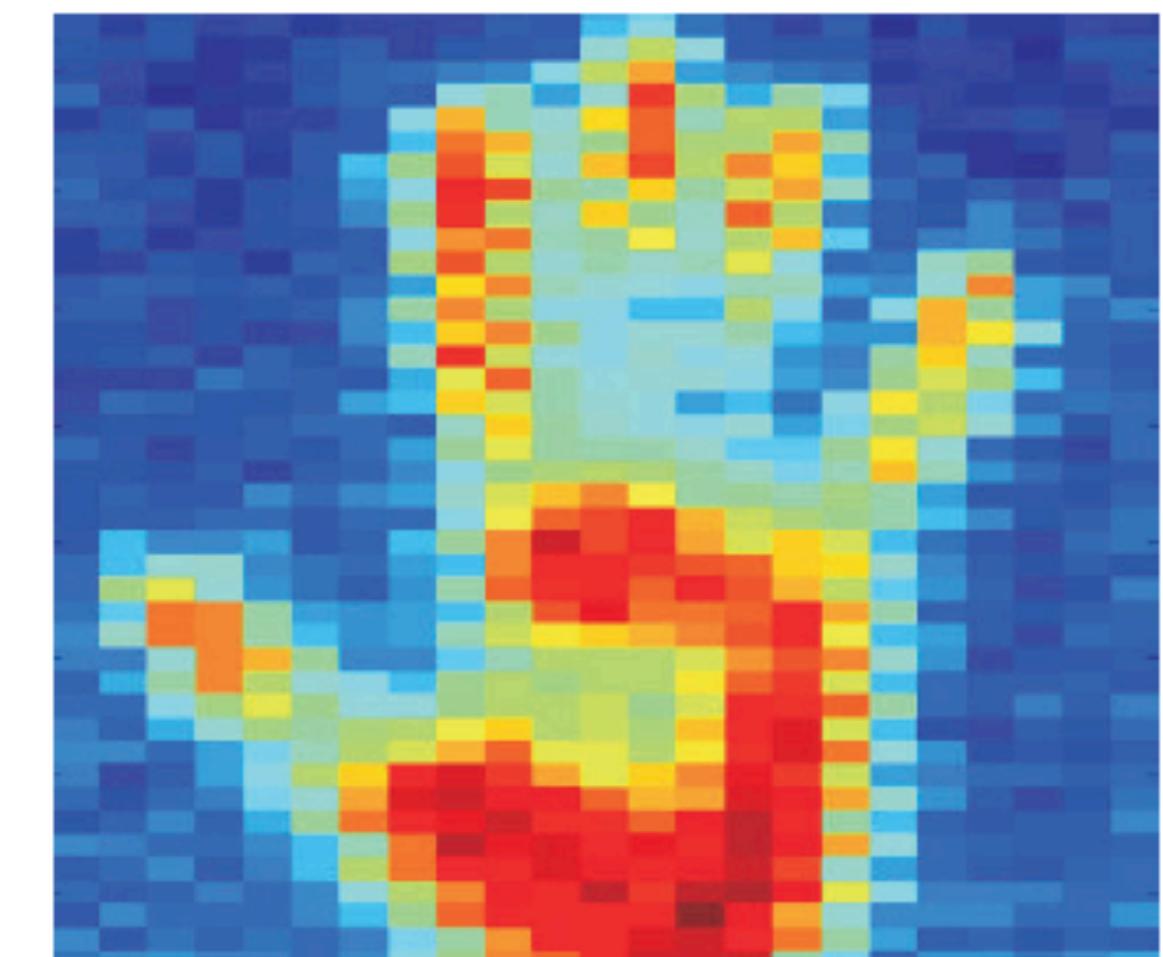
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Raw thermal camera image



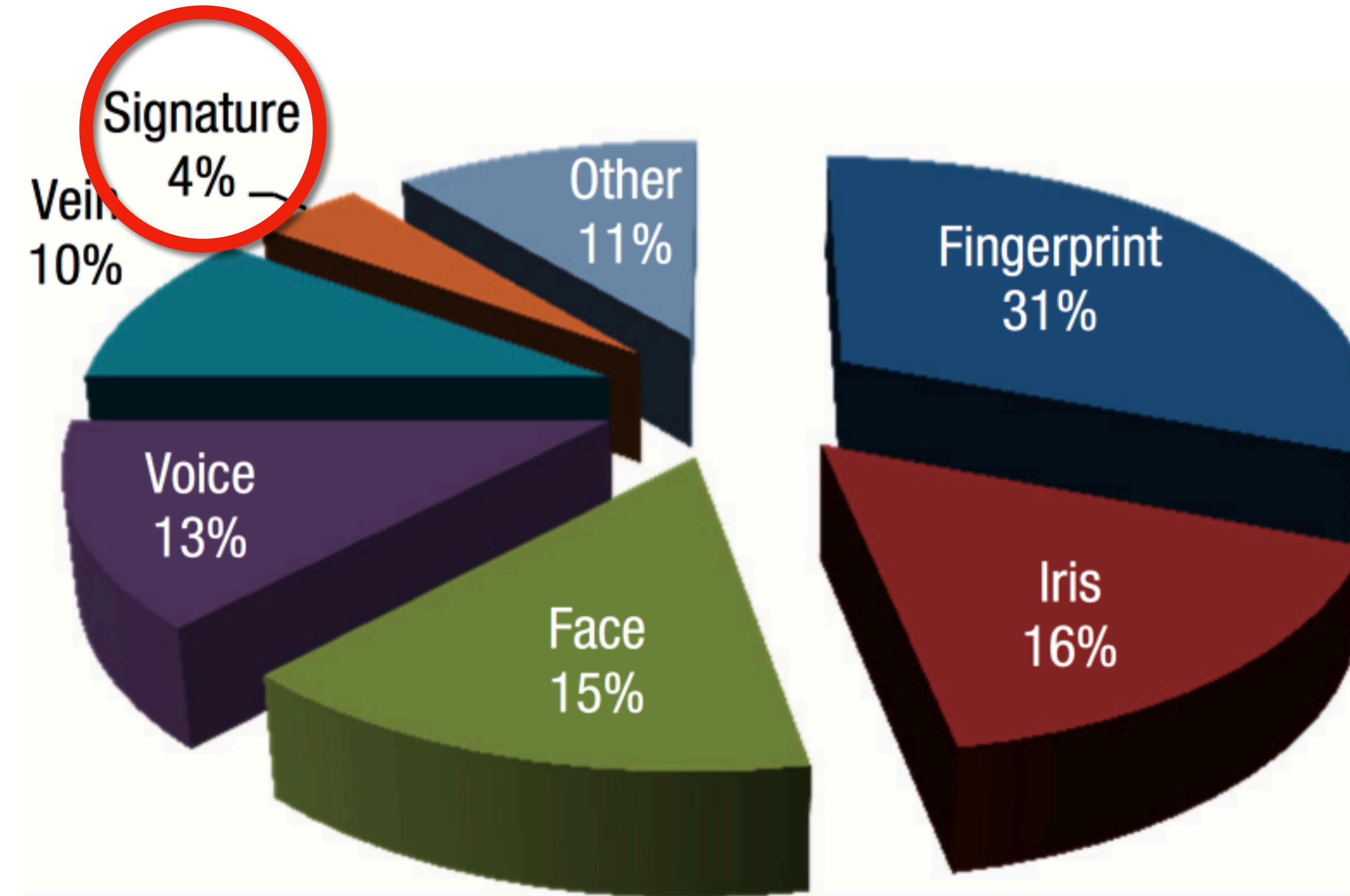
Matrix of thermal sensors



Raw matrix image

Alternative Traits

Market



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

Signature Recognition

Behavioral Trait



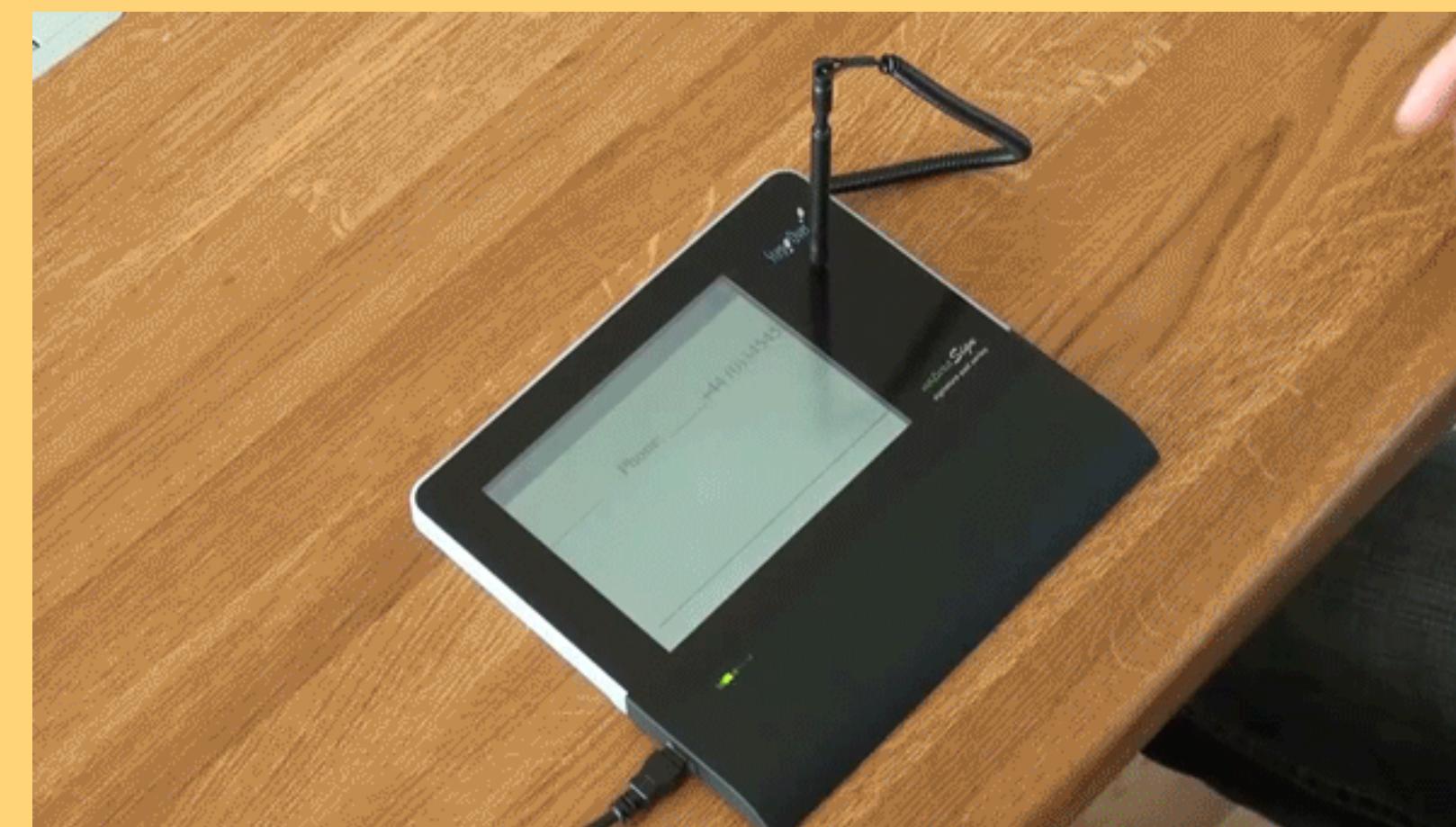
Signature Recognition

Acquisition

Off-line



On-line



[https://www.youtube.com/
watch?v=YI449tOo7Xw](https://www.youtube.com/watch?v=YI449tOo7Xw)

Signature Recognition

Off-line Acquisition

Based on visual content only.

General-purpose sensor
(e.g., scanner, camera).

Not necessarily aided by a computer.

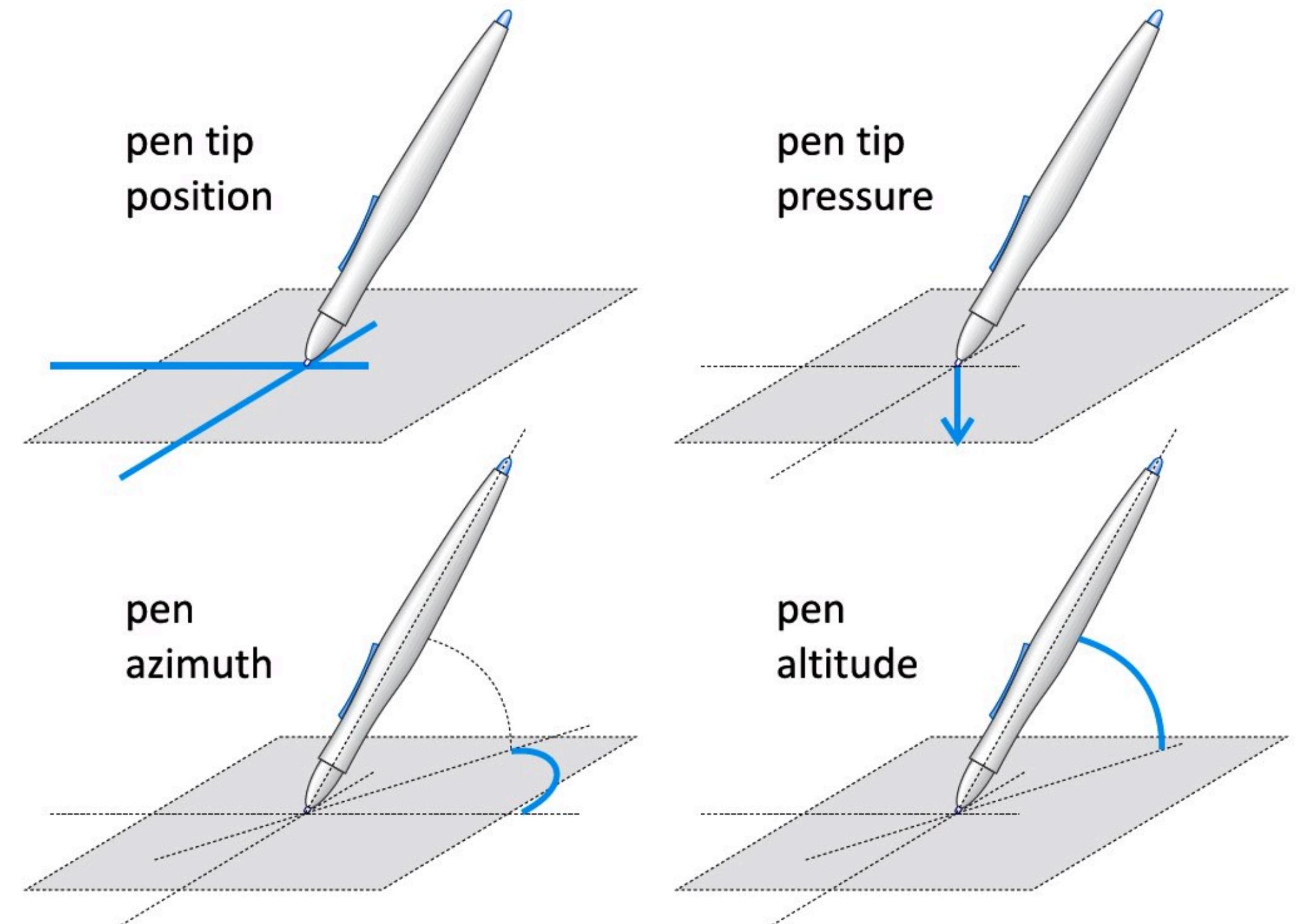


<https://www.youtube.com/watch?v=NPf2otAx8U>

Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.



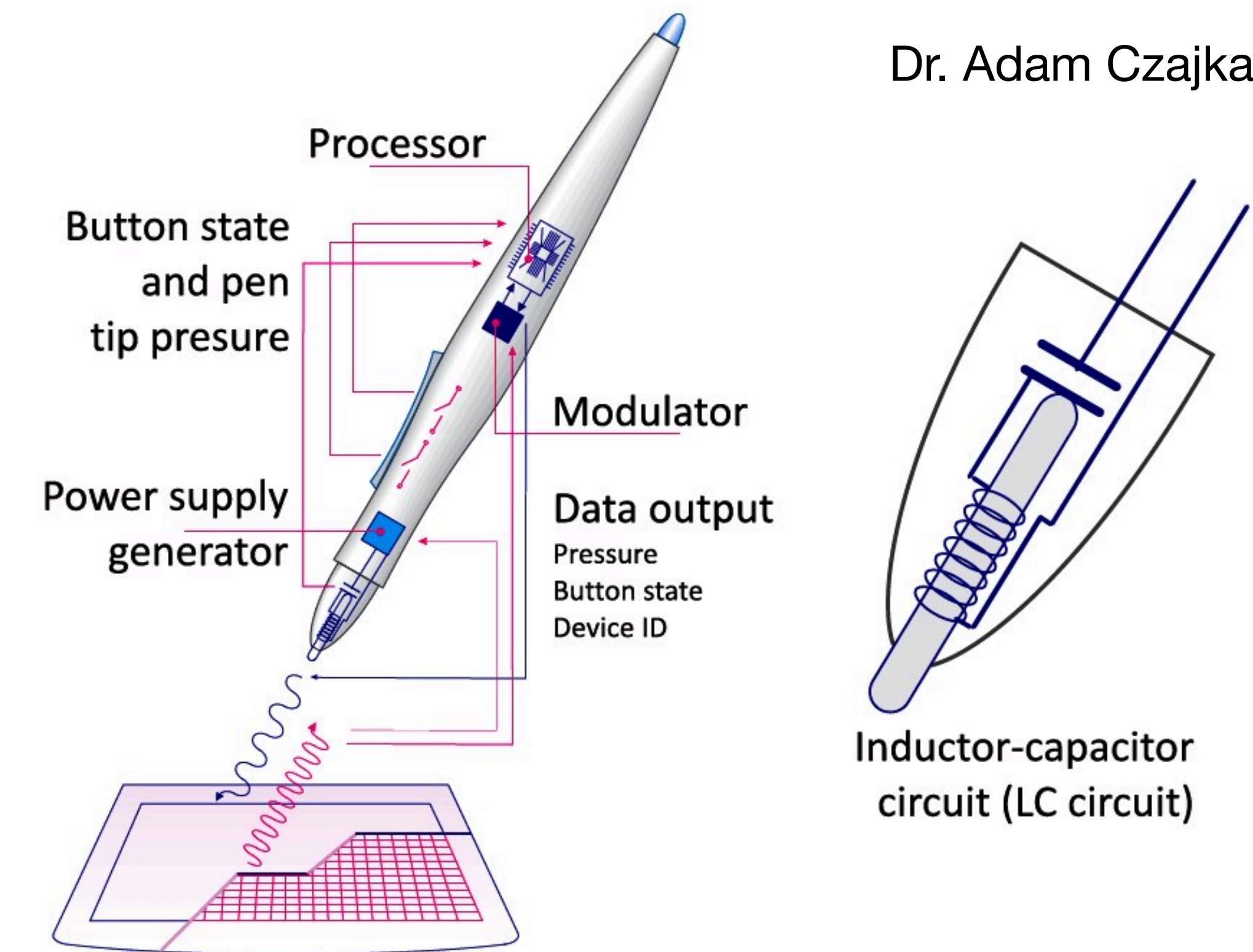
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Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.

Special sensors
(such as digitizing tablets).



Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.

Special sensors
(such as digitizing tablets).



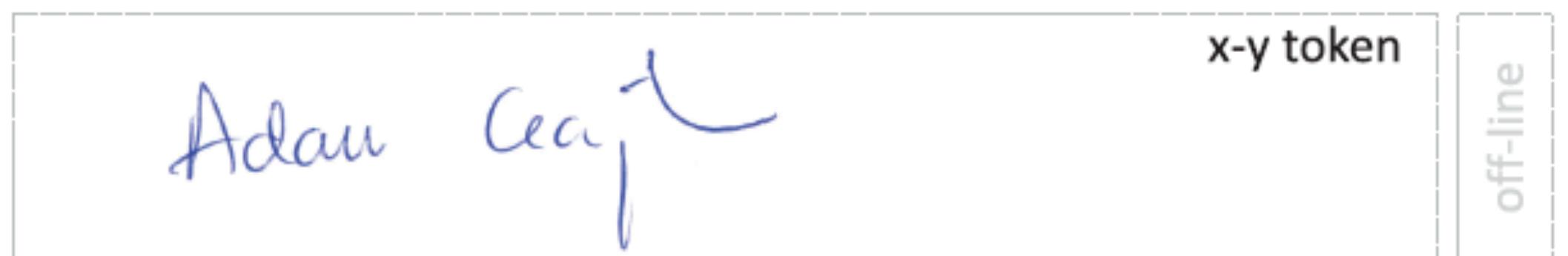
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Aided by computer
(*acquisition, enhancement, feature extraction, matching, decision*).

Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka

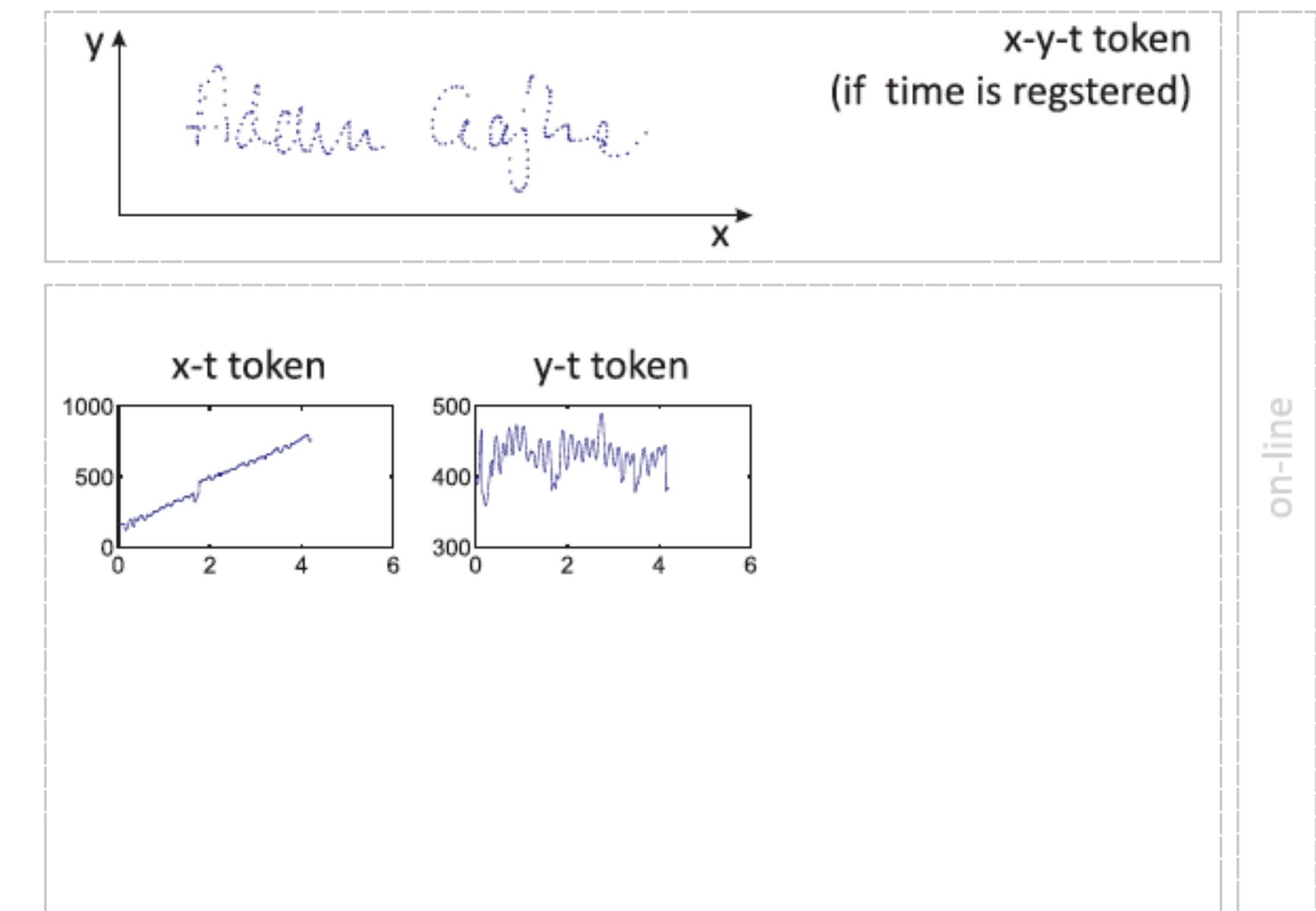
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka



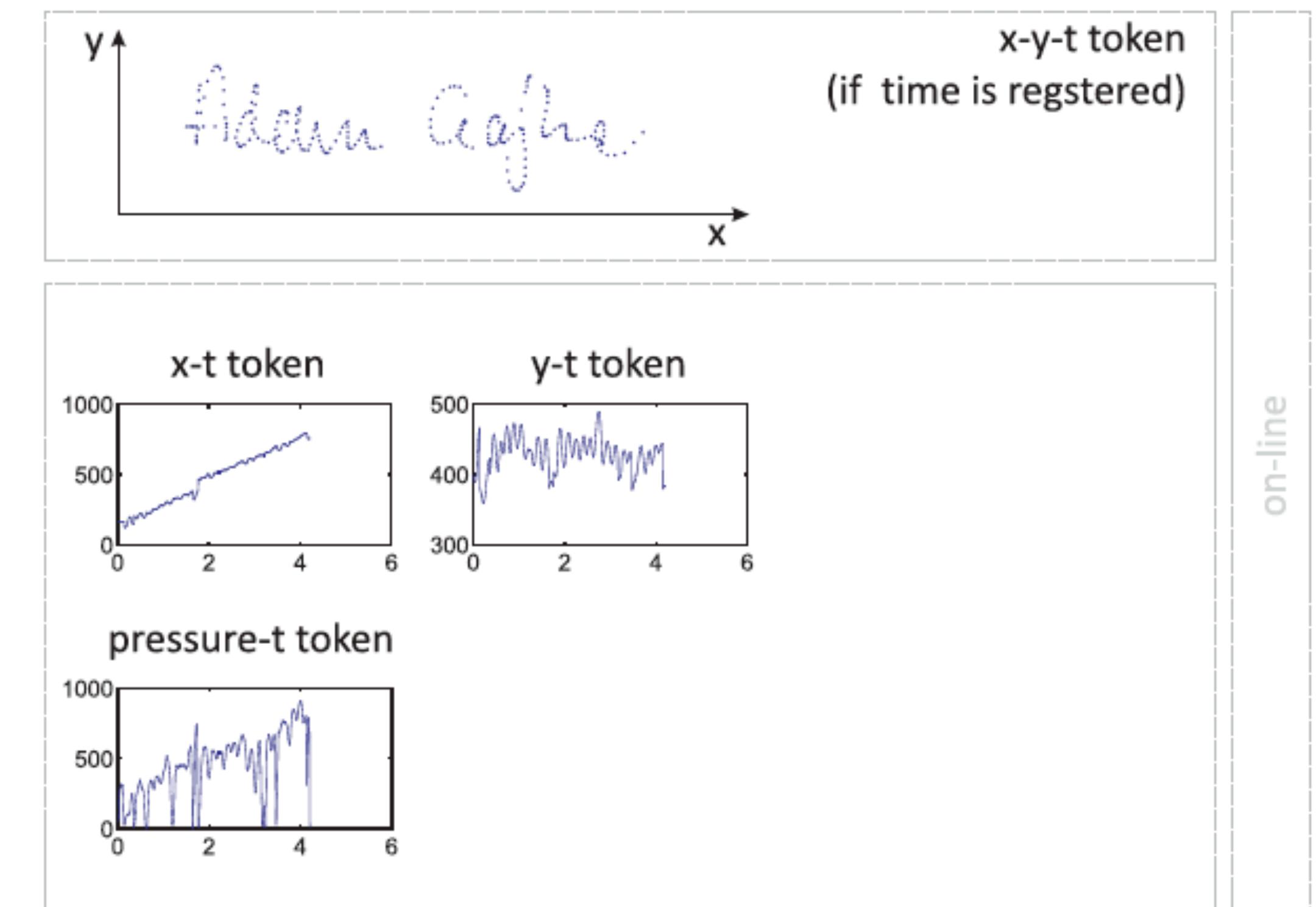
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka



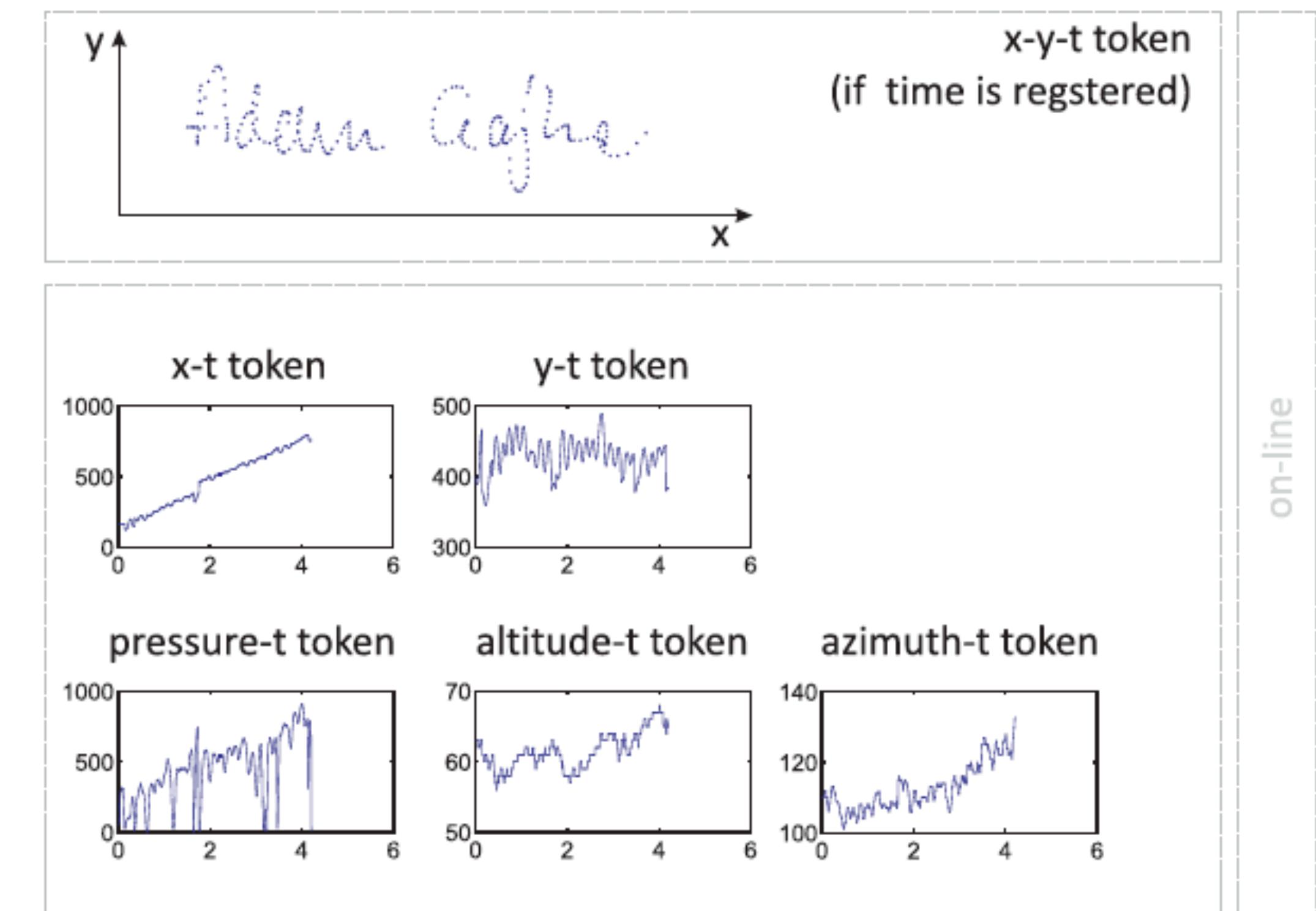
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka



Signature Recognition

Presentation Attack

genuine token

Adam Cea†

Signature Recognition

Presentation Attack

genuine token

Adam Cea†

Whatever,
dude.

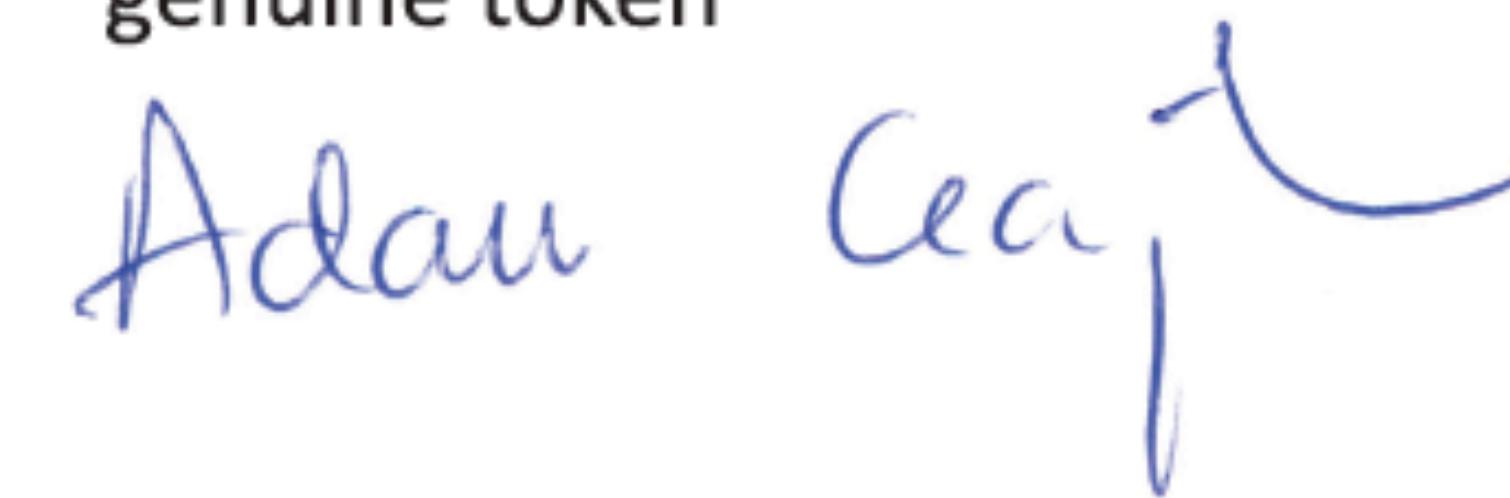
random forgery

PSmehly

Signature Recognition

Presentation Attack

genuine token



Adam Czajka

simple forgery

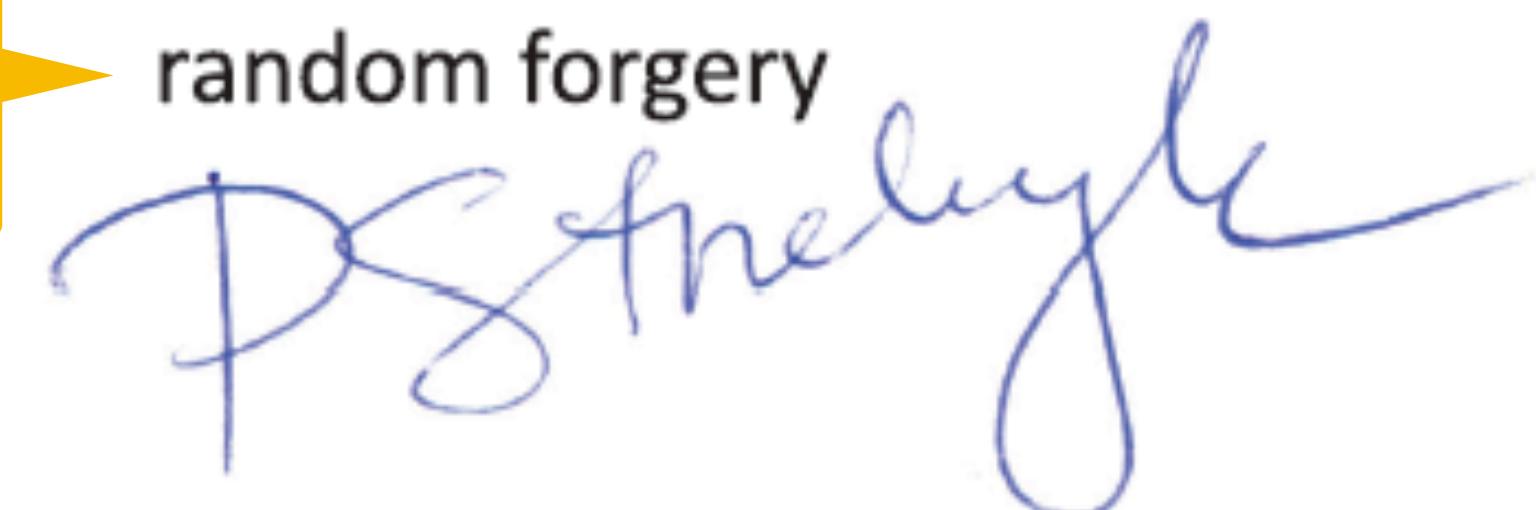


Adam Czajka

I know your
name.

Whatever,
dude.

random forgery



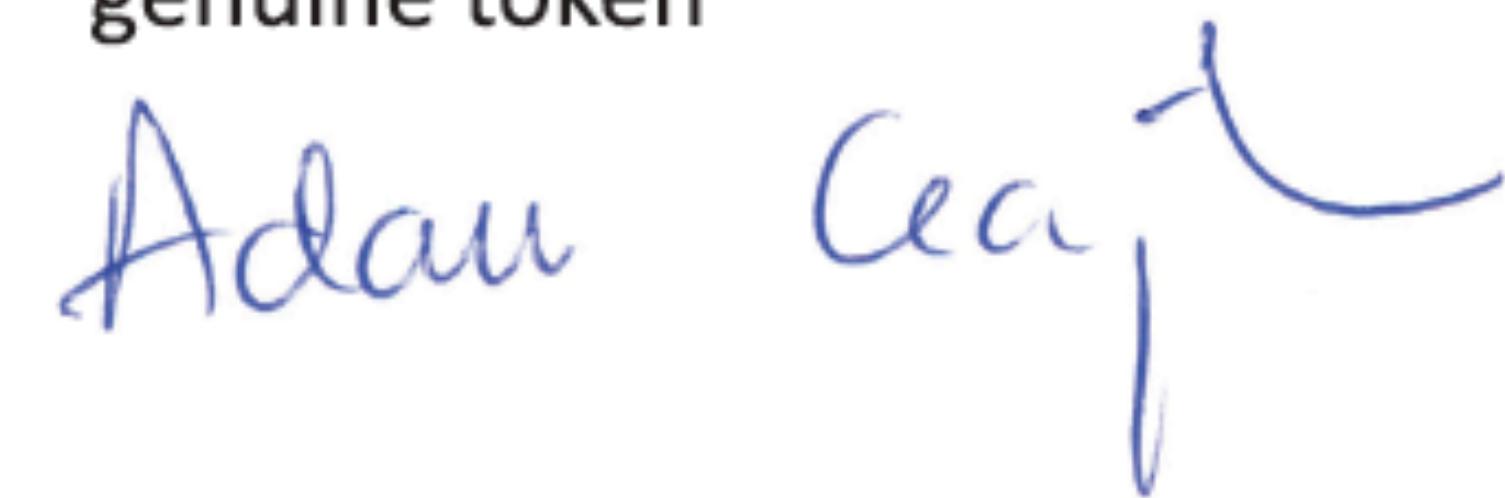
PS Melville

Signature Recognition

Presentation Attack

Dr. Adam Czajka

genuine token



Adam Czajka

simple forgery

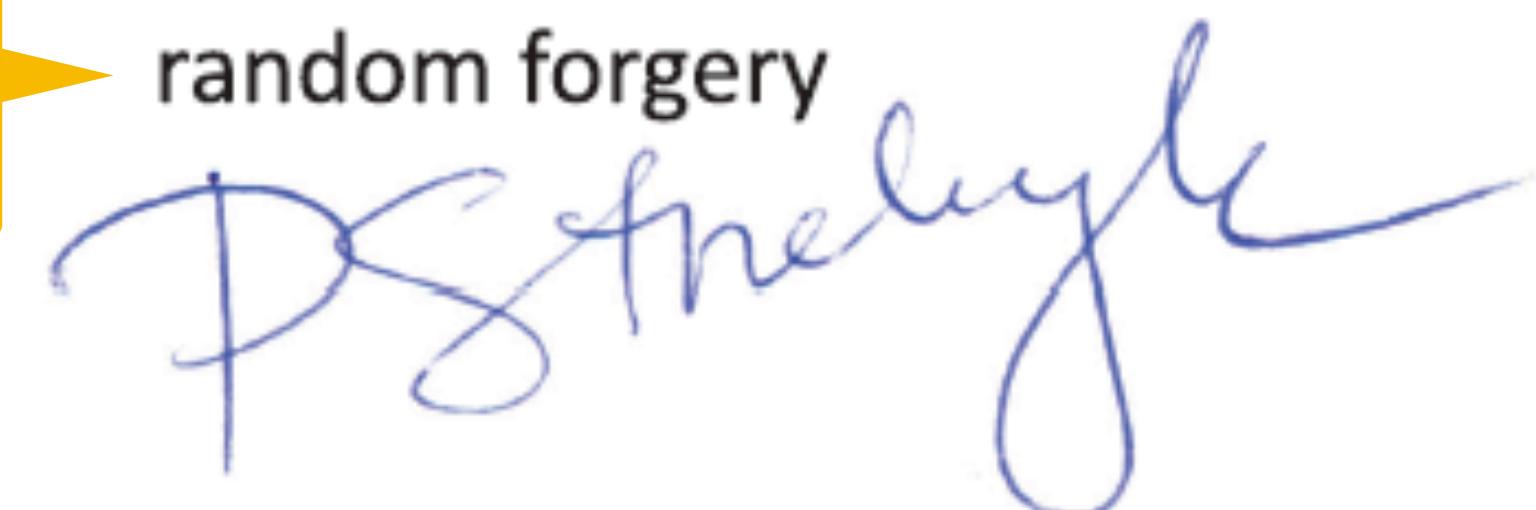


Adam Czajka

I know your name.

Whatever,
dude.

random forgery



PSmehly

skilled forgery

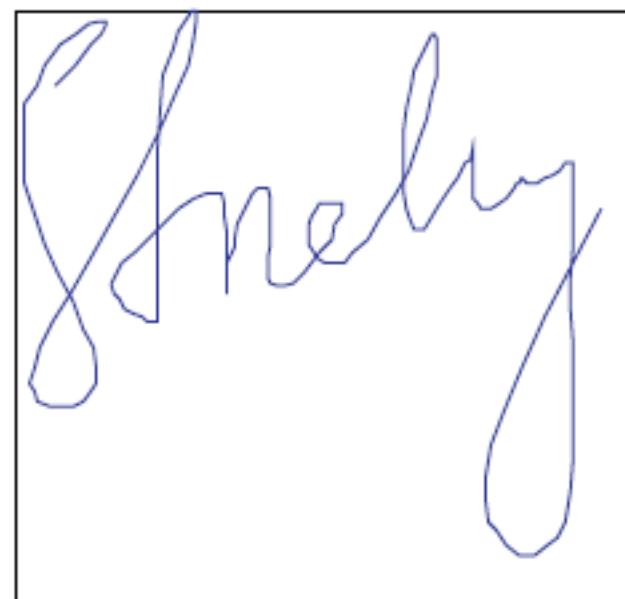


Adam Czajka

I've seen your signature.

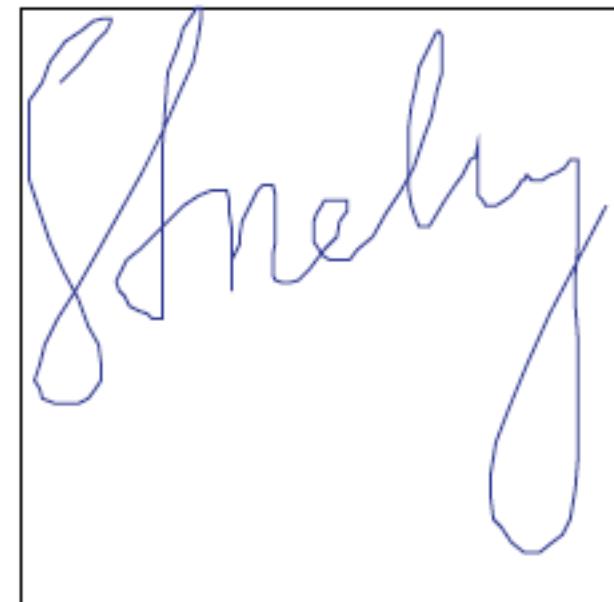
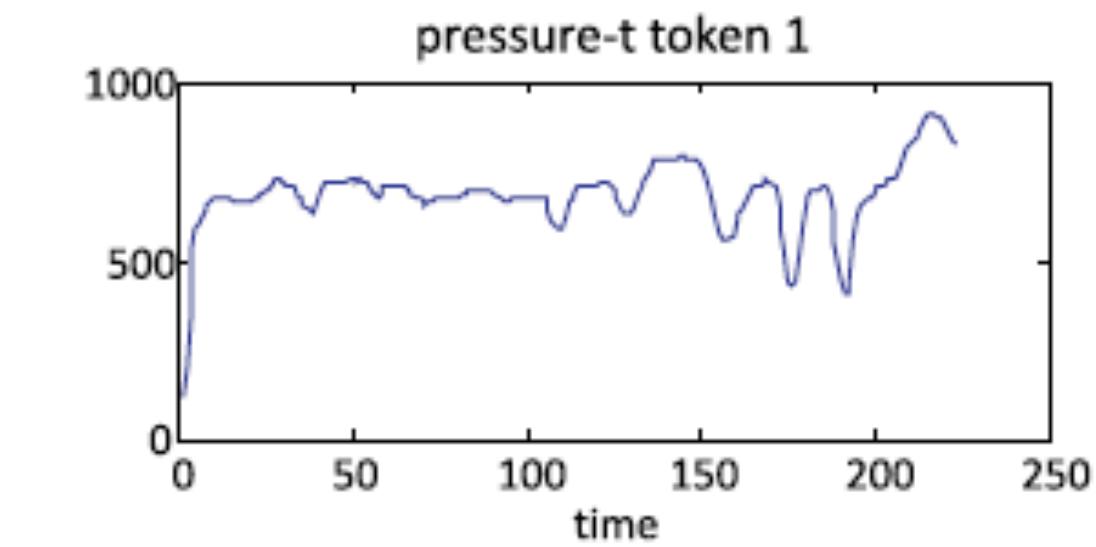
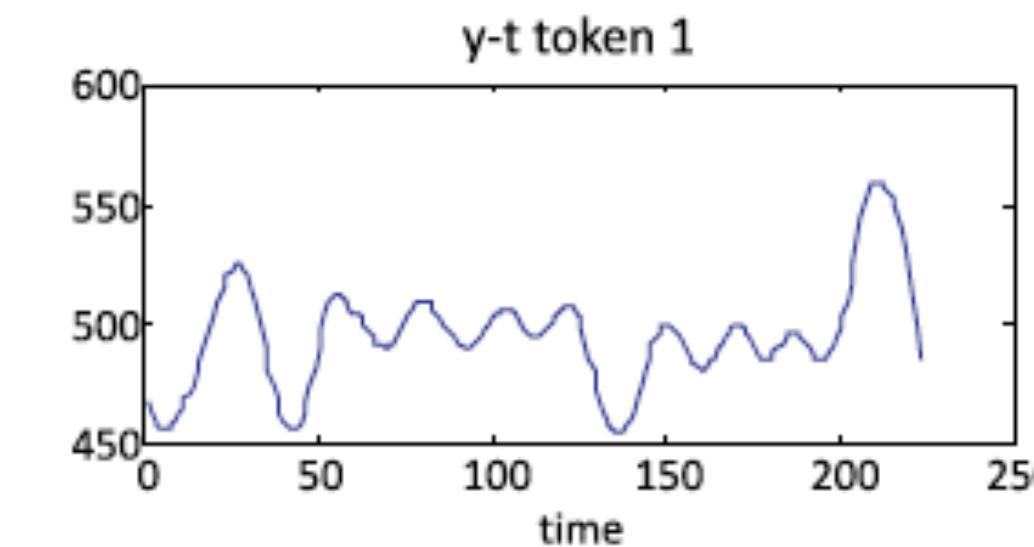
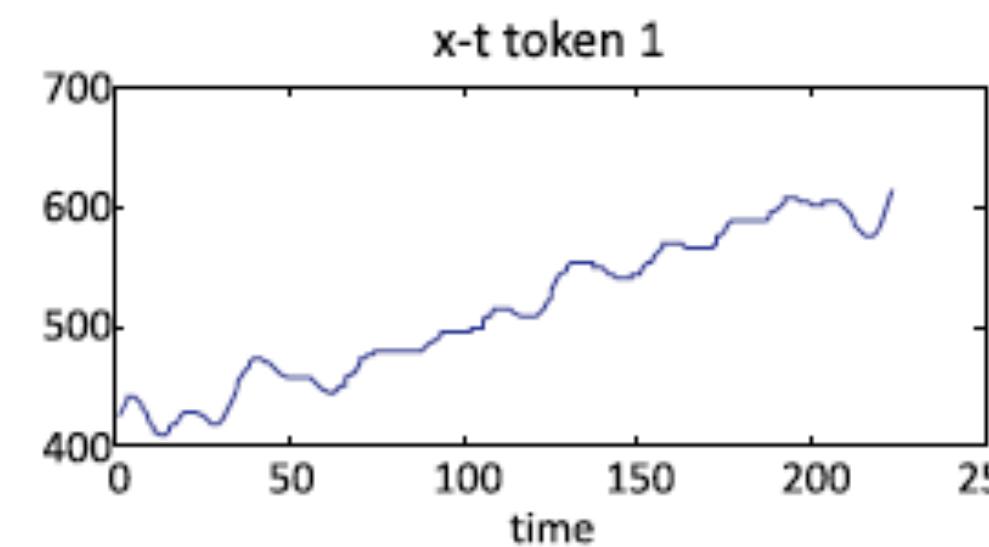
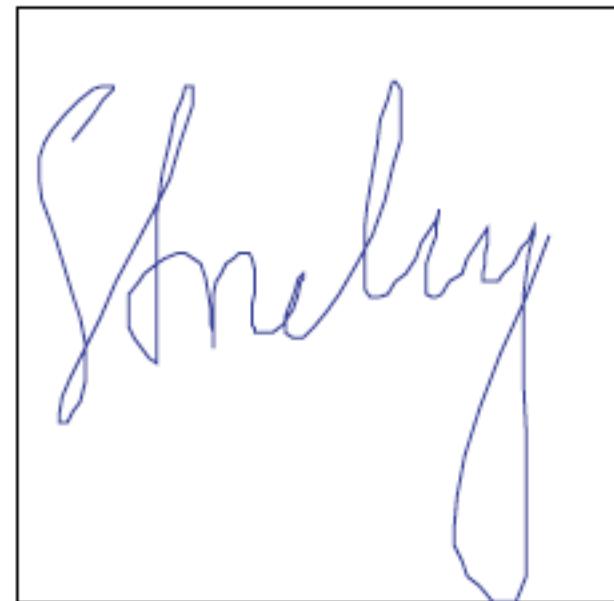
Signature Recognition

Presentation Attack Detection



Signature Recognition

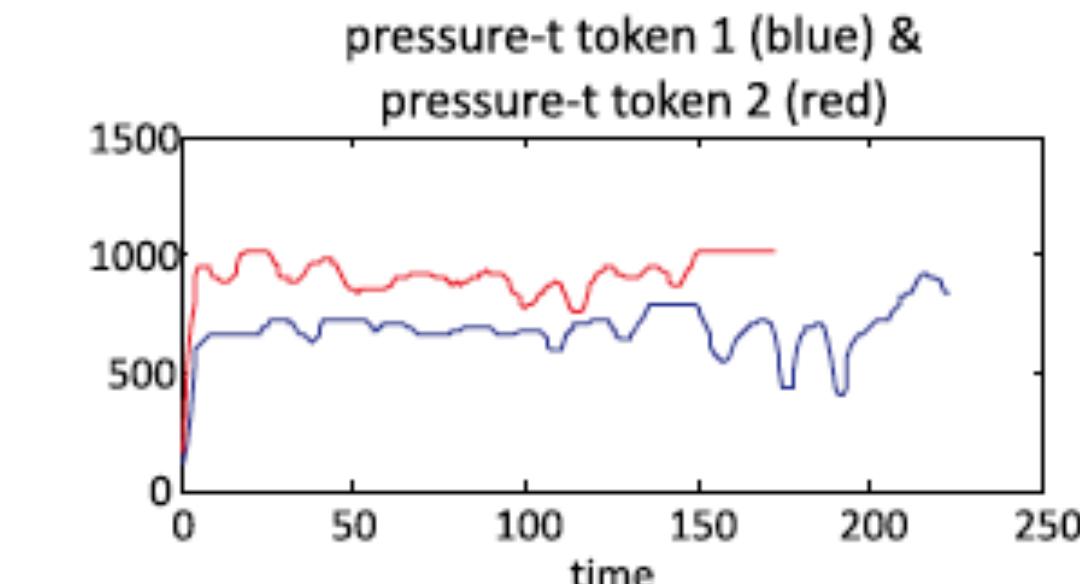
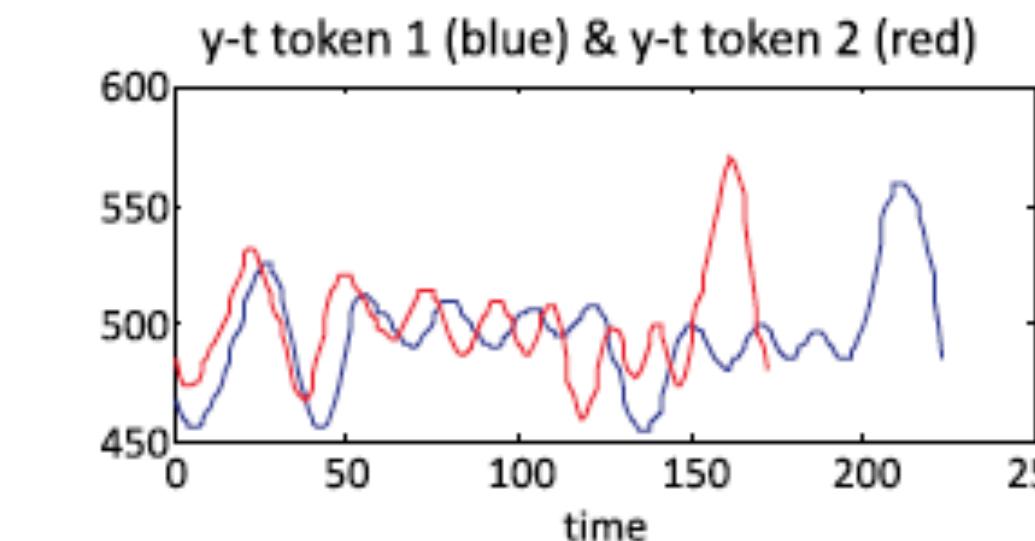
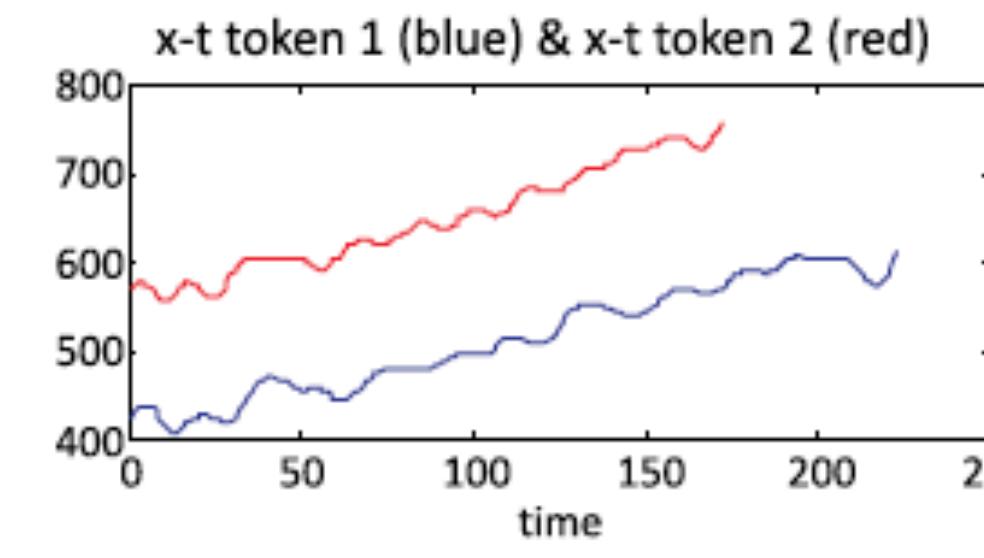
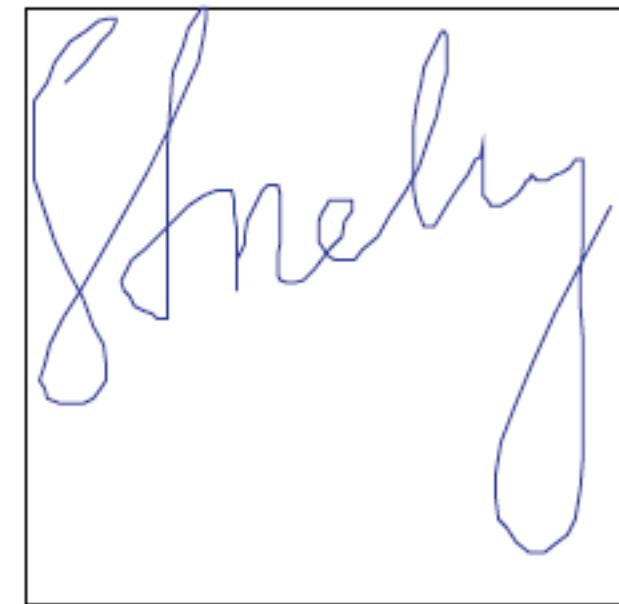
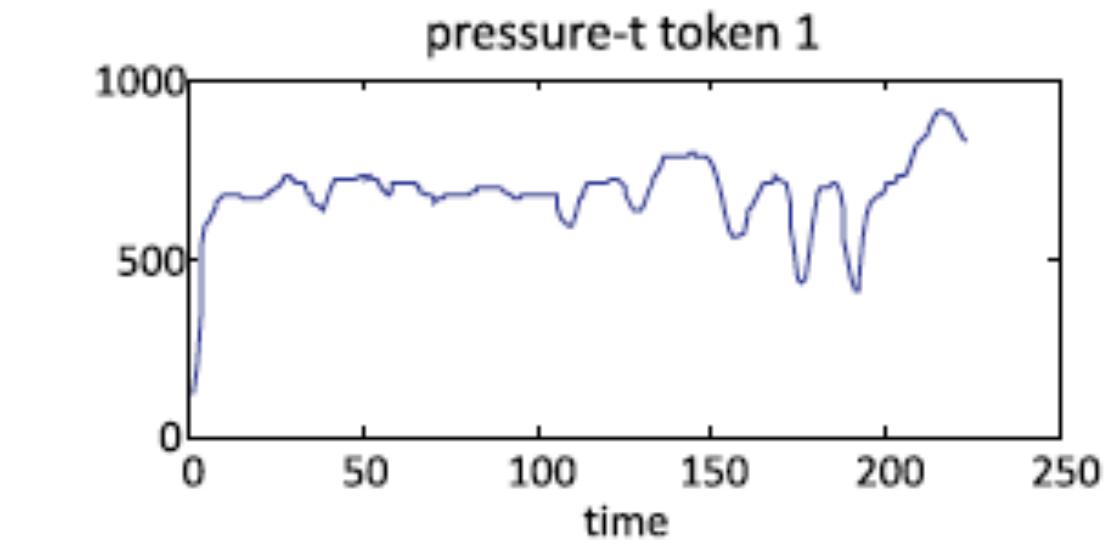
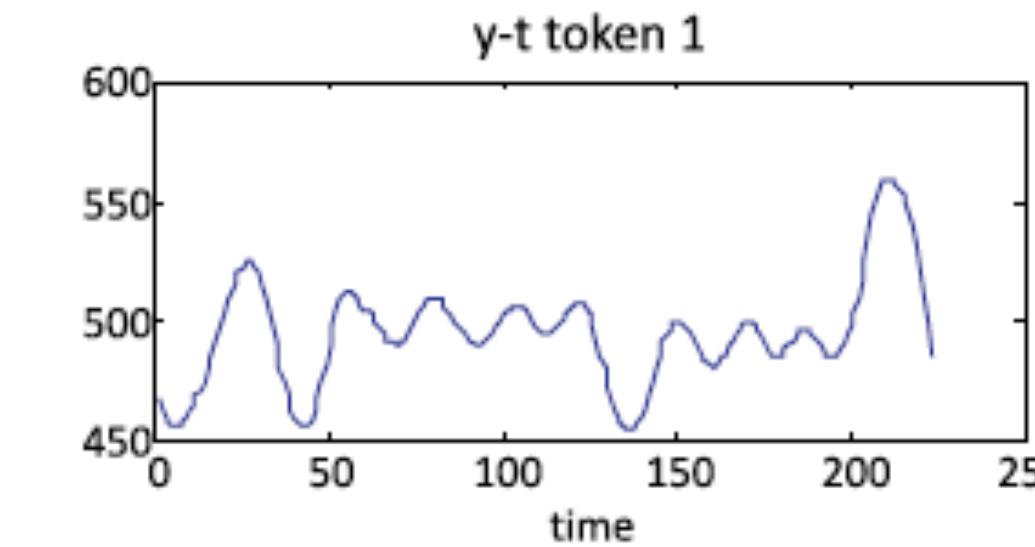
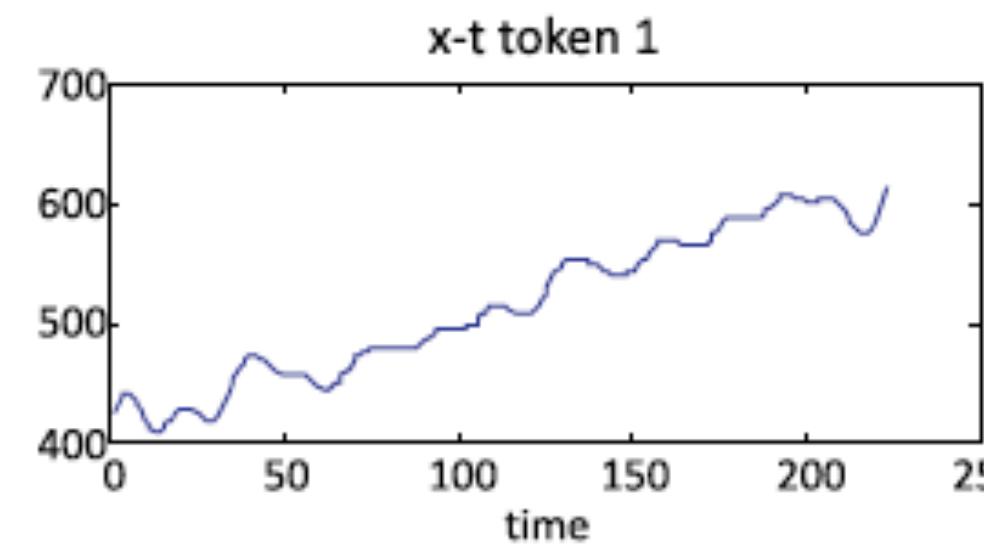
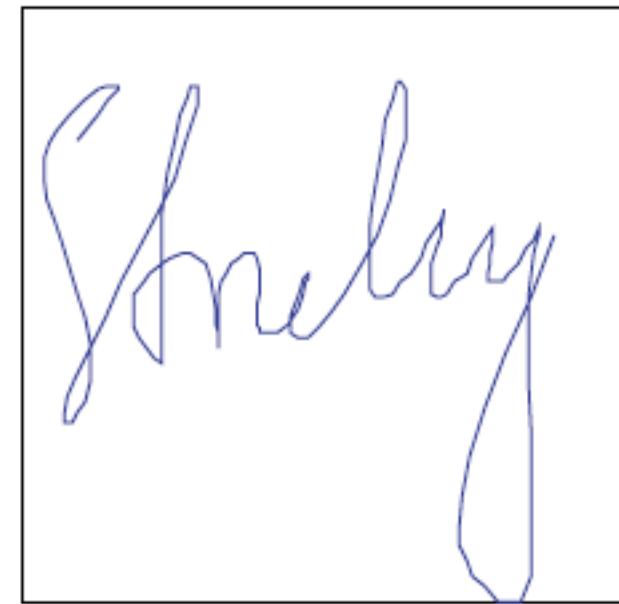
Presentation Attack Detection



Signature Recognition

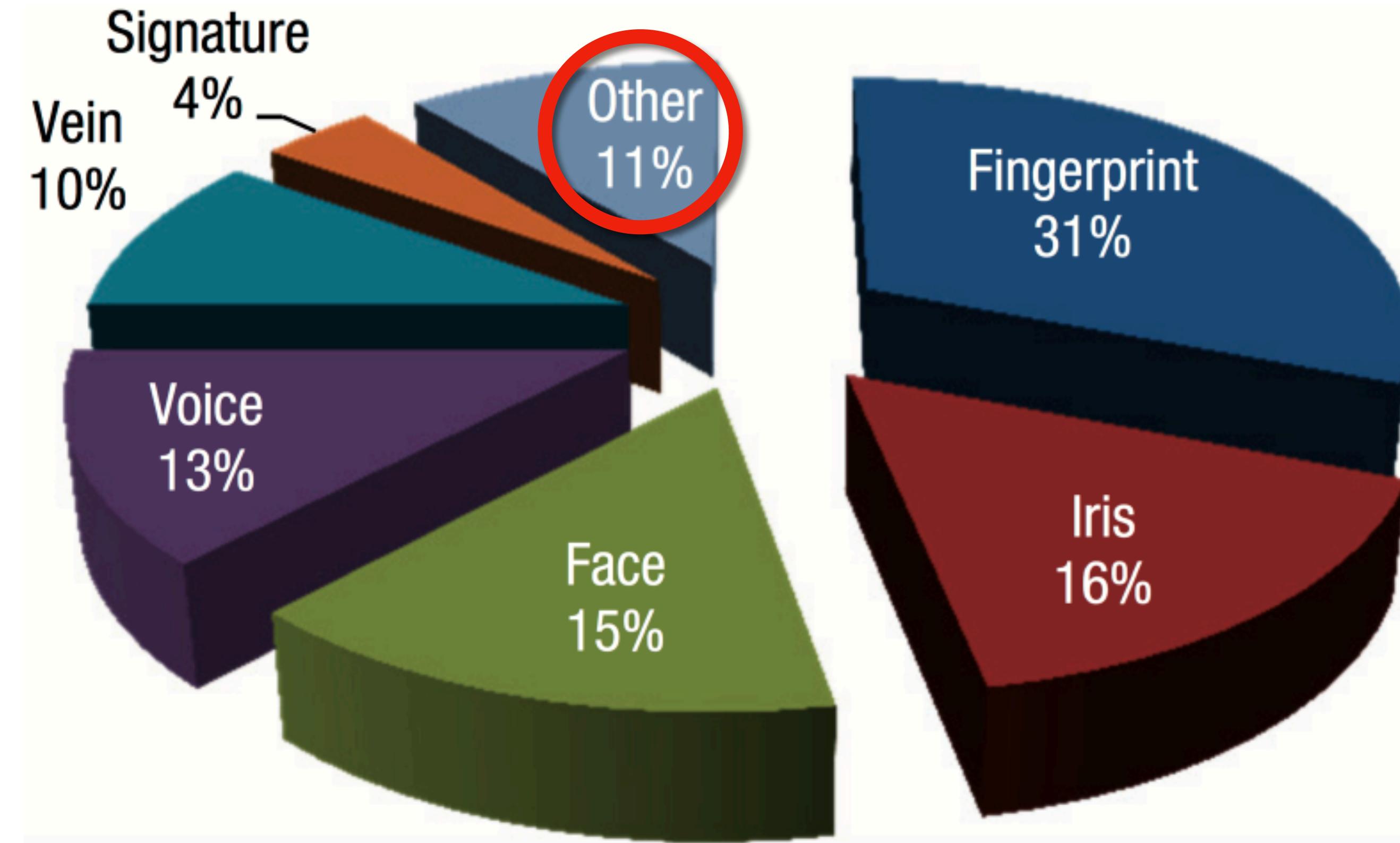
Presentation Attack Detection

Dr. Adam Czajka



Alternative Traits

Market



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

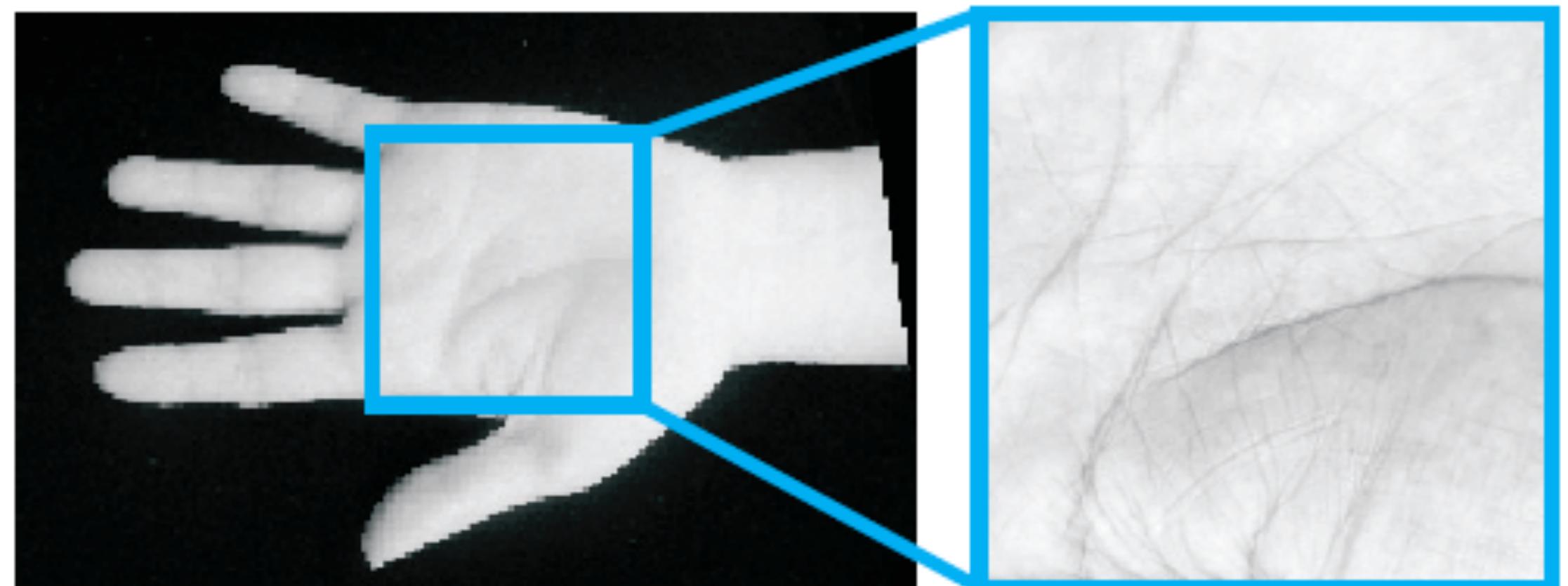
Palmprint Recognition

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.



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

Palmprint Recognition

**On-line
Acquisition**



CrossMatch ID 2500
Dr. Adam Czajka



Other Traits



DNA



Gate



Ears



Tongue Print

Other Traits

Ahem...

naked security by SOPHOS

PRODUCTS > FREE TOOLS > FREE SOPHOS HOME >

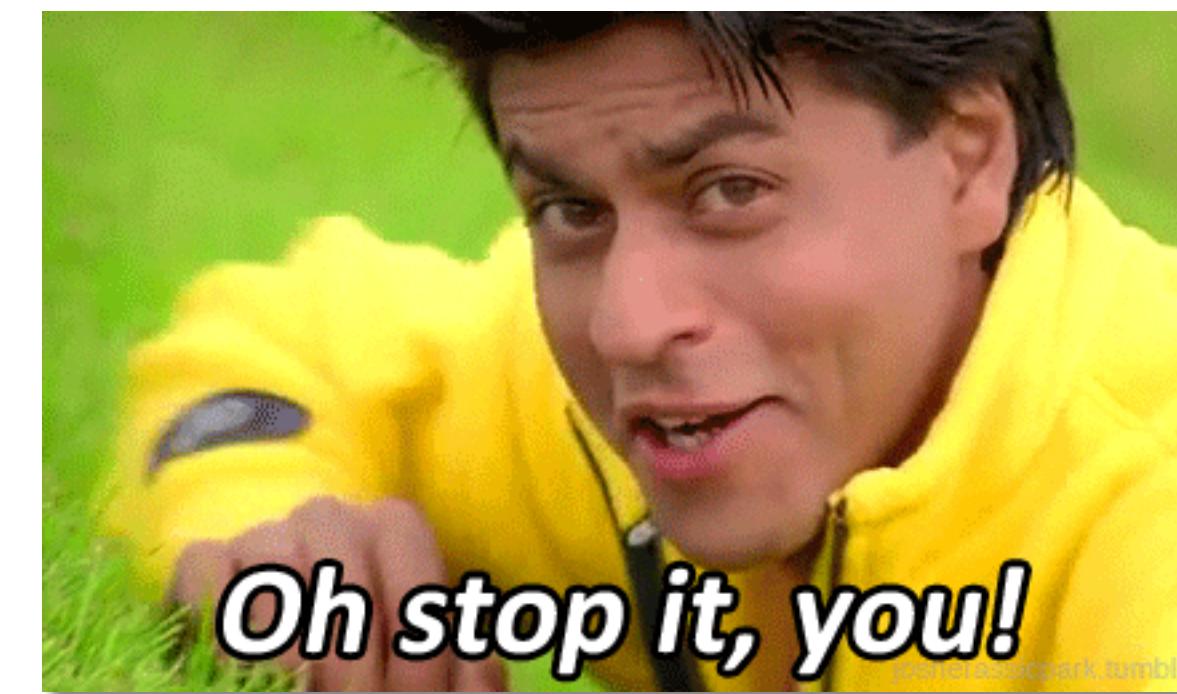
Have you listened to our podcast? [Listen now](#)

As if the world couldn't get any weirder, this AI toilet scans your anus to identify you

08 APR 2020 8 Privacy



<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

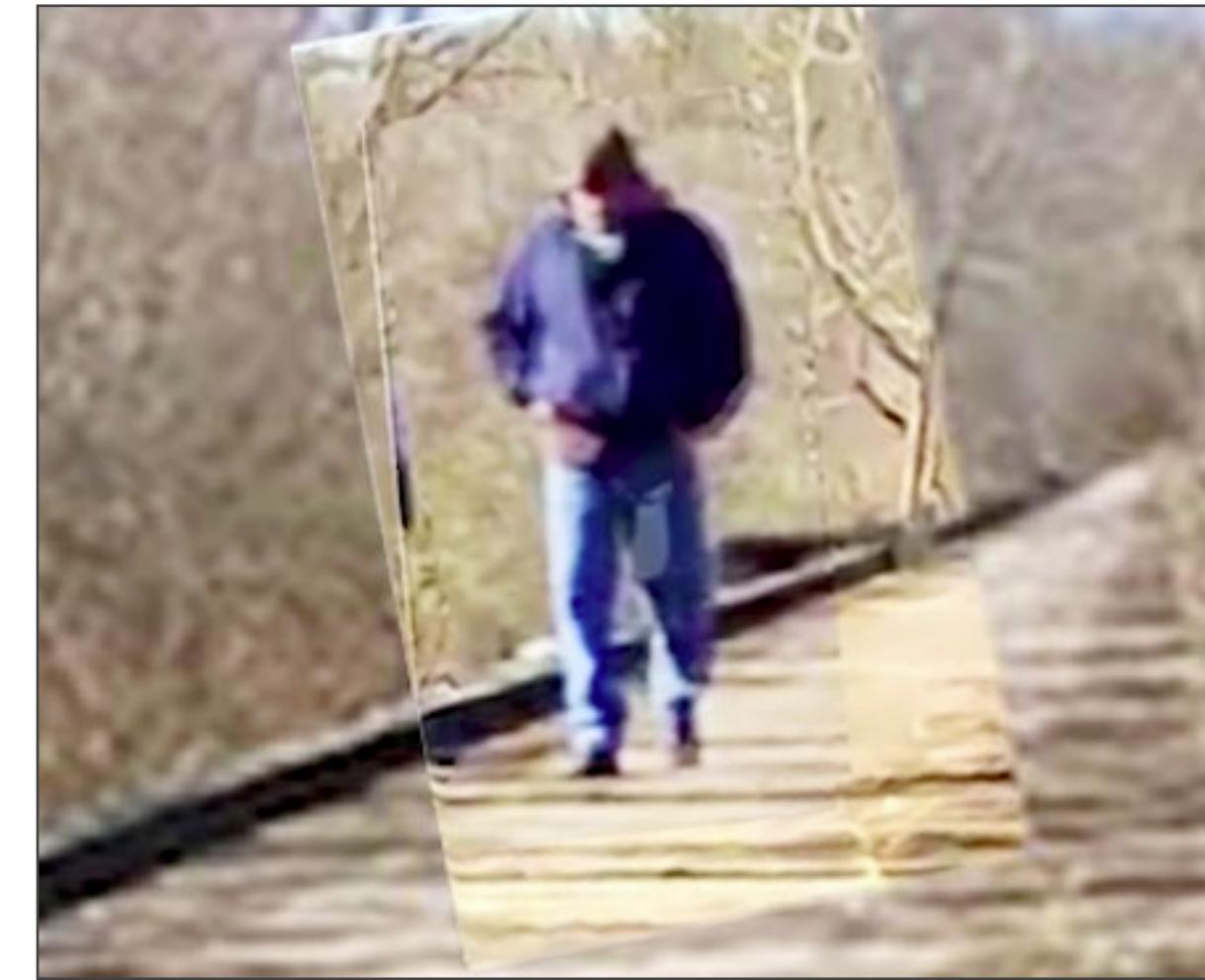
Soft Biometrics

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

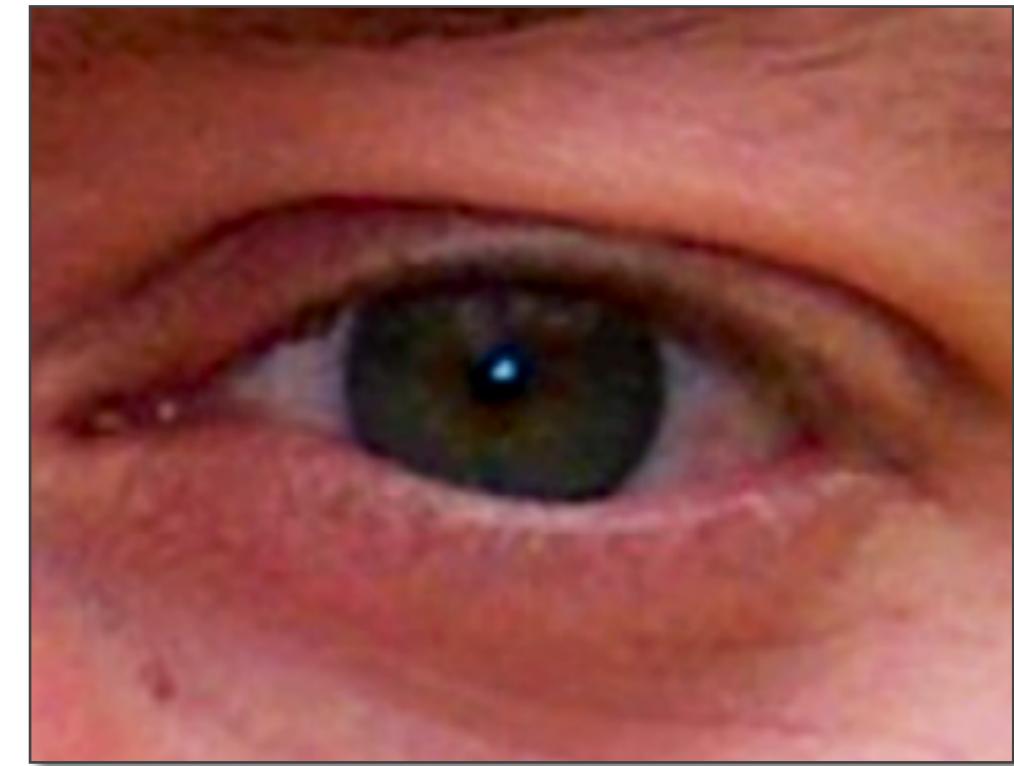
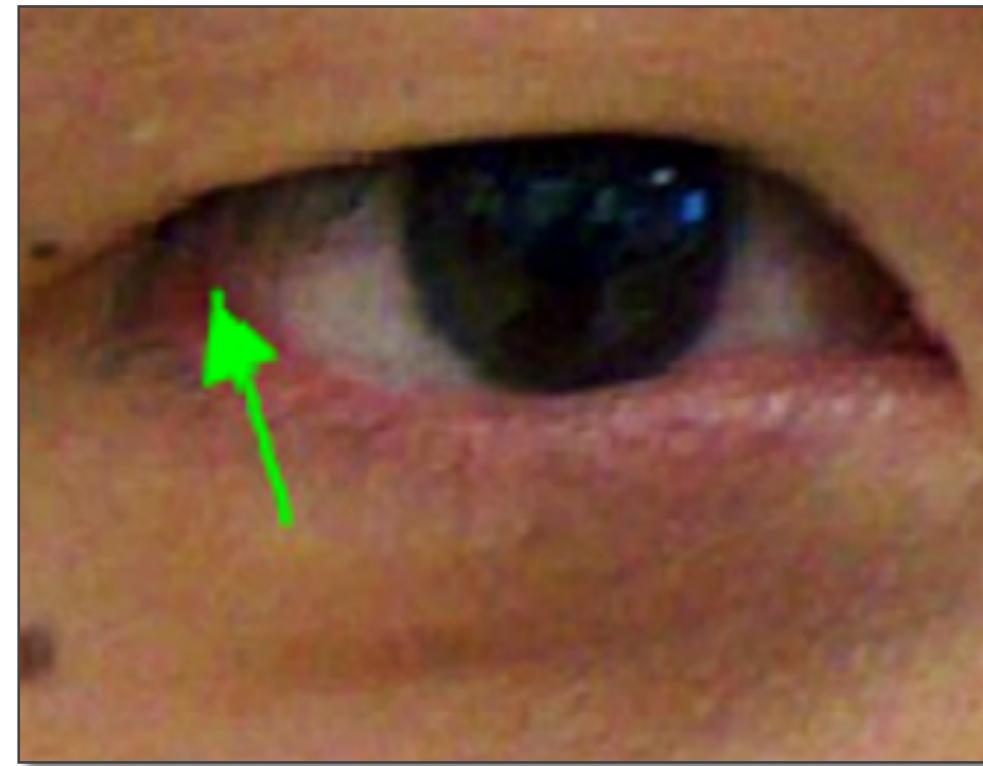
<https://bit.ly/3u81gXd>

Soft Biometrics

What can you guess?

Periocular region and eye color

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

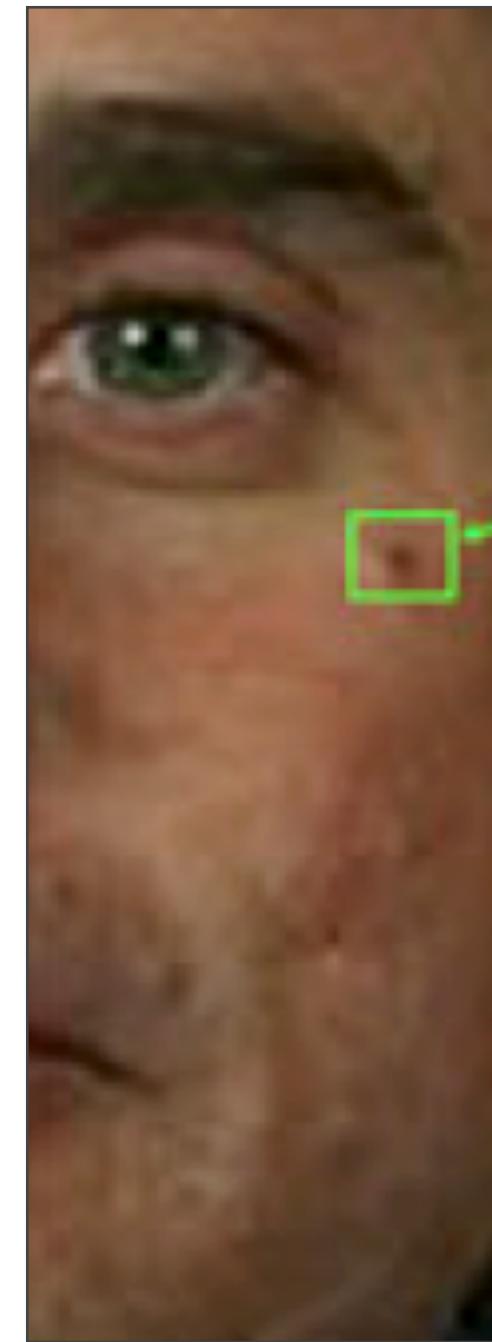


Gender?
Ethnicity?
Age?

Soft Biometrics

Other traits

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



moles, scars,
marks



birthmarks



tattoos

Multibiometrics

Pick a Trait

Universality (1/8)

Does everybody have the trait?

Uniqueness (2/8)

How likely two or more individuals will present the same trait?

Permanence (3/8)

How easily does the trait change?

Measurability (4/8)

How easy is it to acquire and digitize the trait?



Multibiometrics

Pick a Trait

Acceptability (5/8)

Will individuals collaborate during data collection?



Circumvention (6/8)

How hard can the trait be forged or imitated?

Performance (7/8)

How good is the trait quantitatively according to objective metrics?

Accountability (8/8)

How easy is it for the everyman to understand the trait comparison?

Multibiometrics

Pick a Trait

There is no silver bullet.
No trait satisfies all concepts.



Multibiometrics

Solution

Rely on multiple traits.
Allow various presentations.
Combine results (data fusion).



Pros

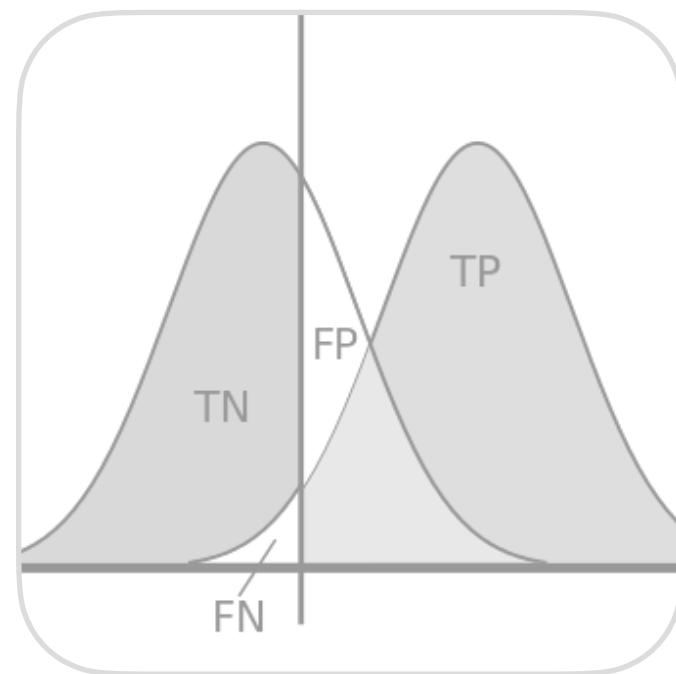
More concepts can be satisfied.
System is more robust to attacks.
It becomes more expensive
to attack the system.

Cons

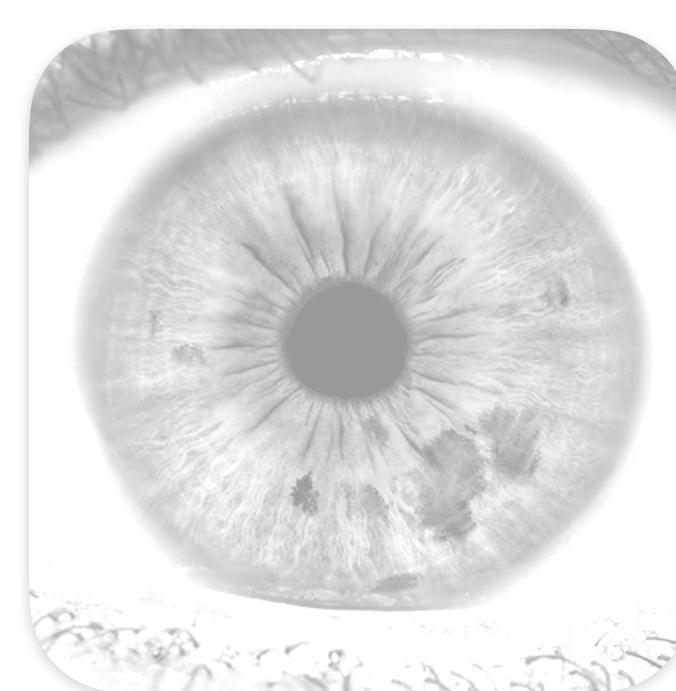
System becomes more expensive
(more sensors, more software).
More runtime.
More complexity.

S'up Next?

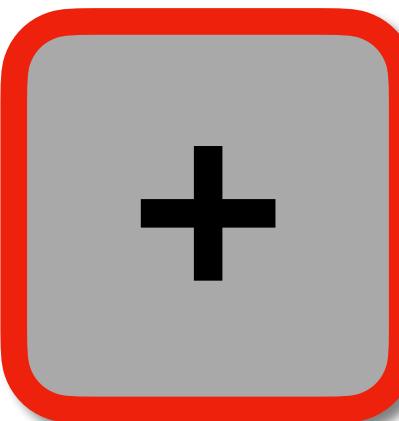
Fusion (a.k.a. Multibiometrics)



Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
Evaluation
Assignments



Alternative Traits and
Fusion
Concepts



Invited Talks (2)
State of the art
Future work