Other Traits

COMP 388-002/488-002 Biometrics

Daniel Moreira

Fall 2025

LOYOLA
UNIVERSITY CHICAGO

Today we will…

Get to know
Alternative traits and
soft biometrics.

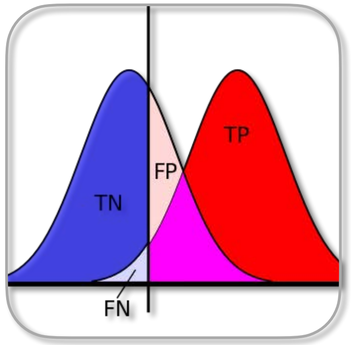
Today's Attendance

Please fill out the form

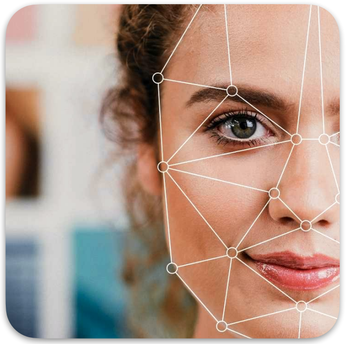
forms.gle/UQNuYkihqje5xcYk9

Course Overview

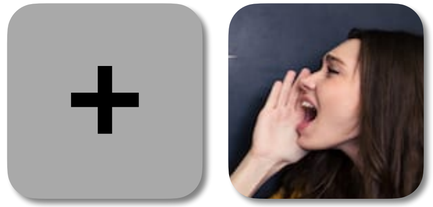
Content



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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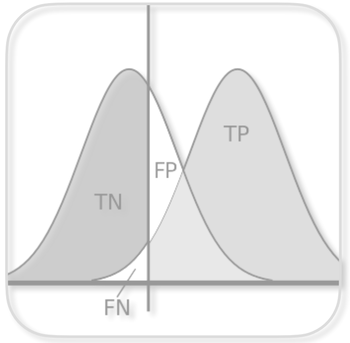

Basics
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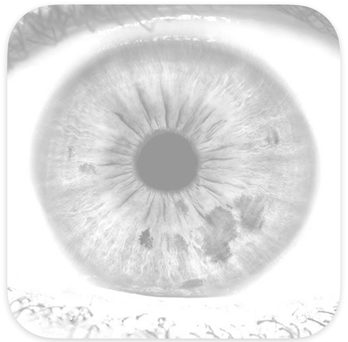

Core Traits (3)
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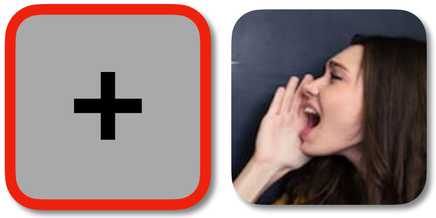

Alternative Traits and Fusion
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Invited Talks (2)
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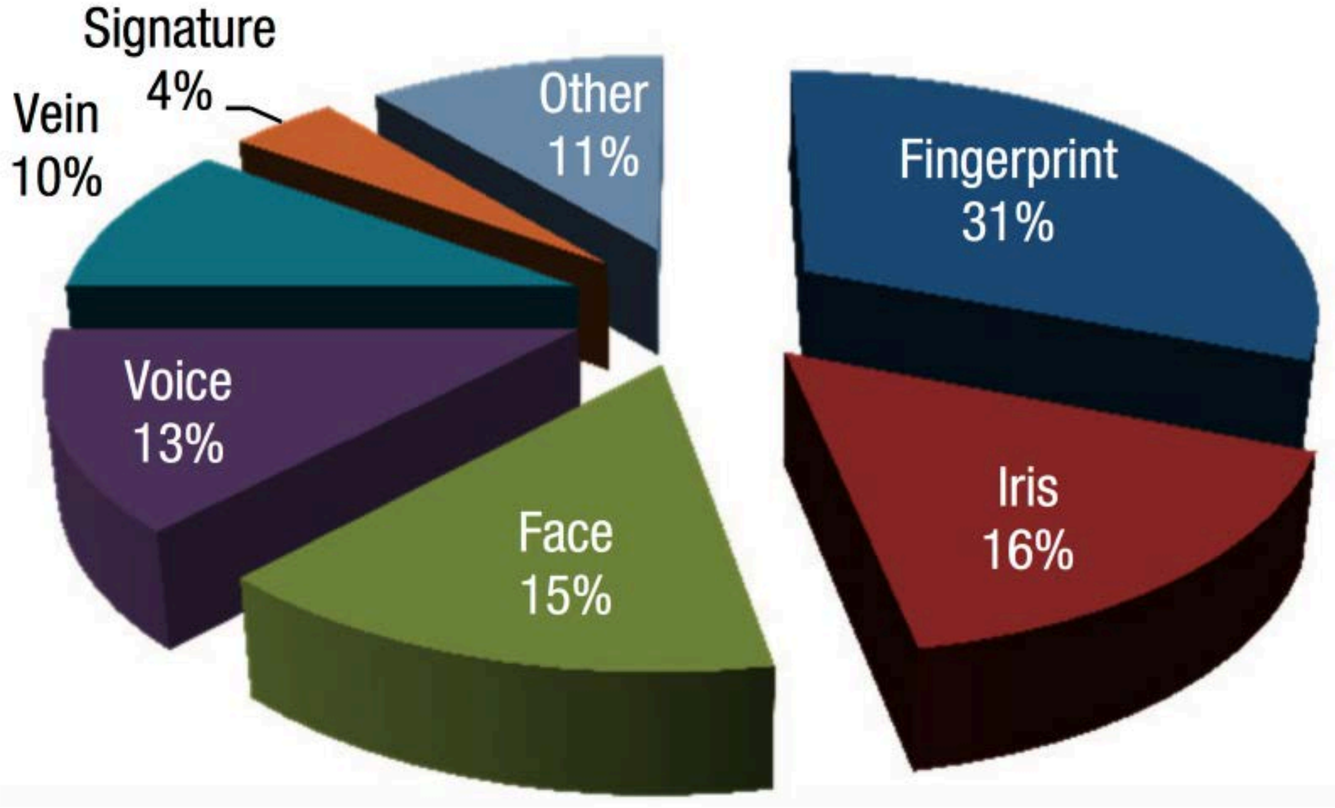
Alternative Traits

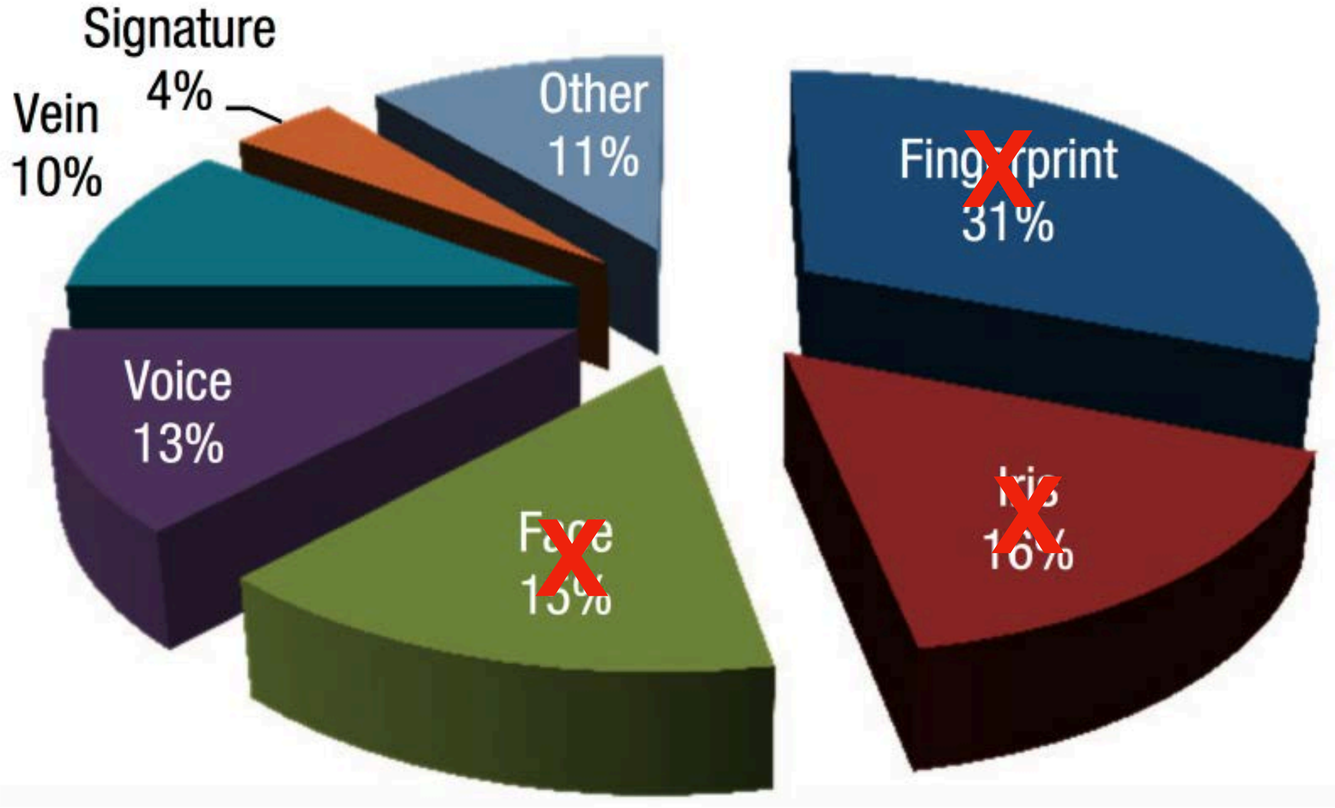
Market



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

Alternative Traits

Market



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Alternative Traits

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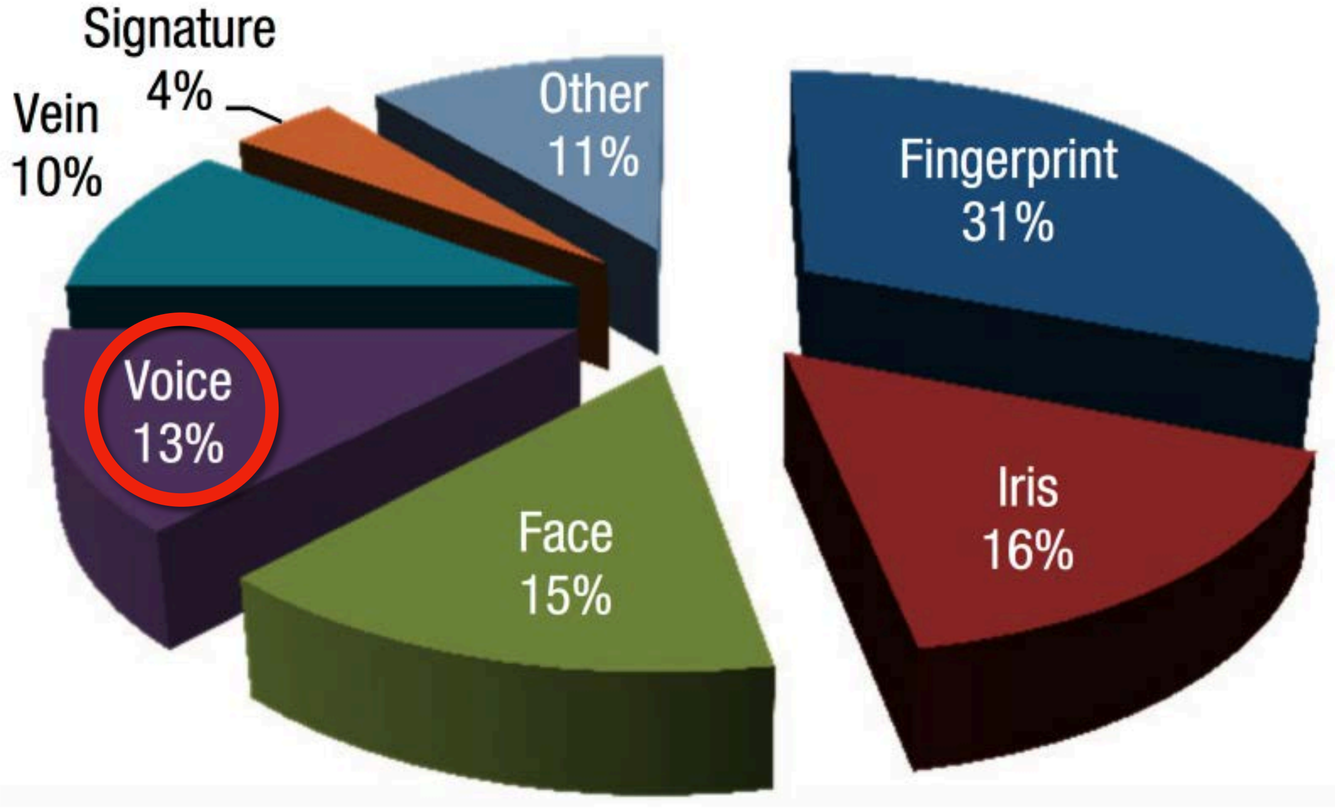


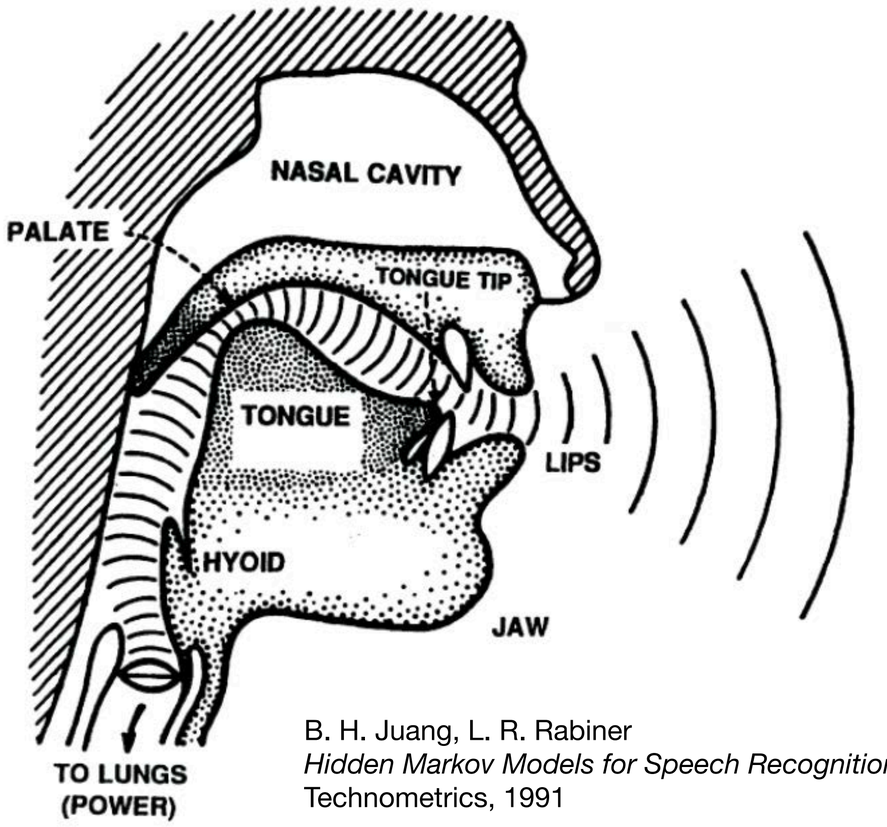
Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

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.

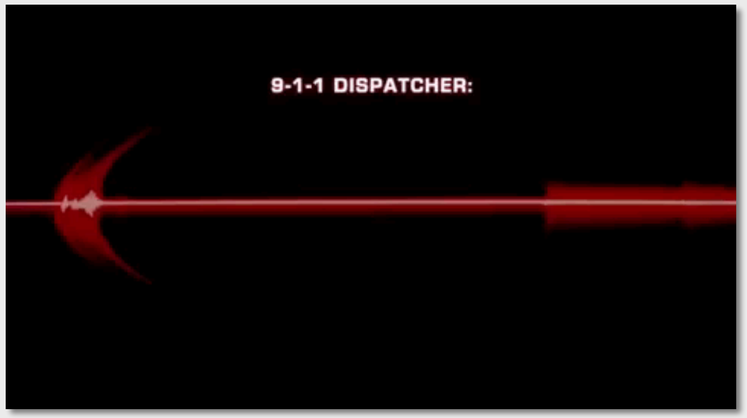


B. H. Juang, L. R. Rabiner
Hidden Markov Models for Speech Recognition
Technometrics, 1991

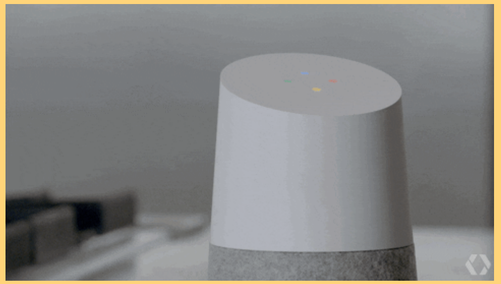
Voice Recognition

Acquisition

Off-line



On-line



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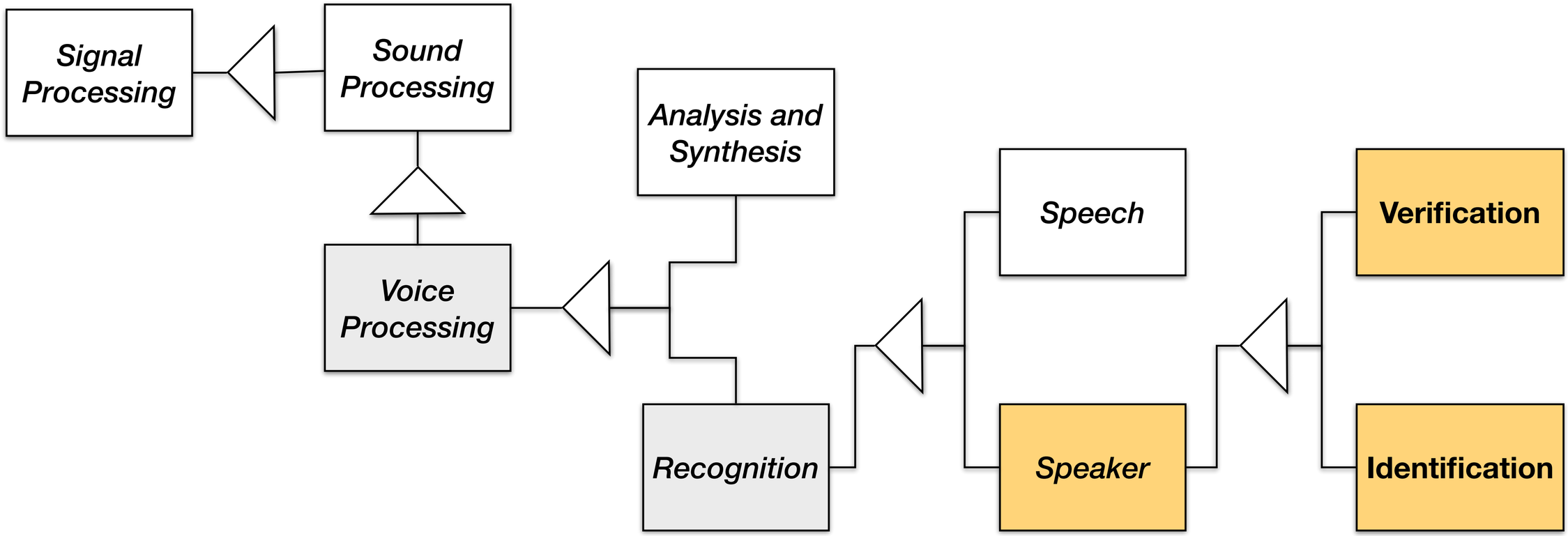
Voice Recognition

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.

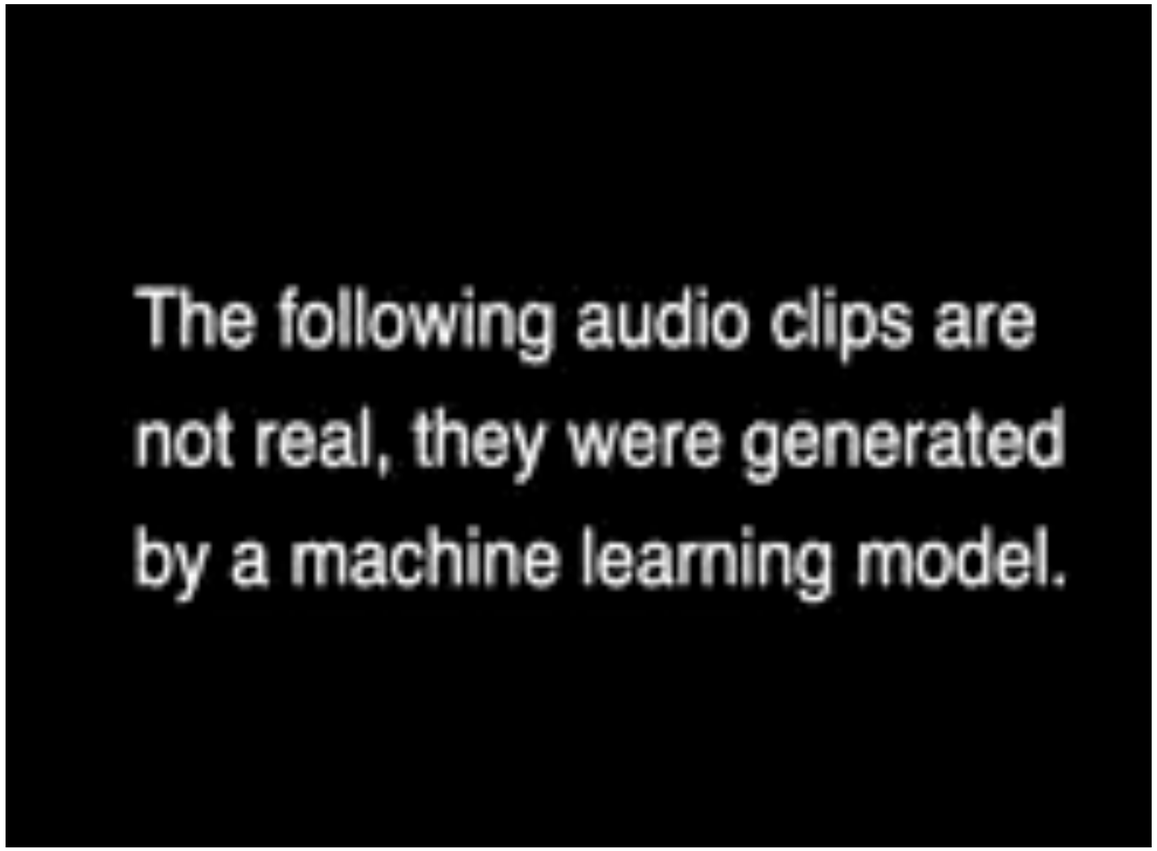
Conversational (under development)
Speech and speaker recognition,
with semantic analysis.

Security

increases

Voice Recognition

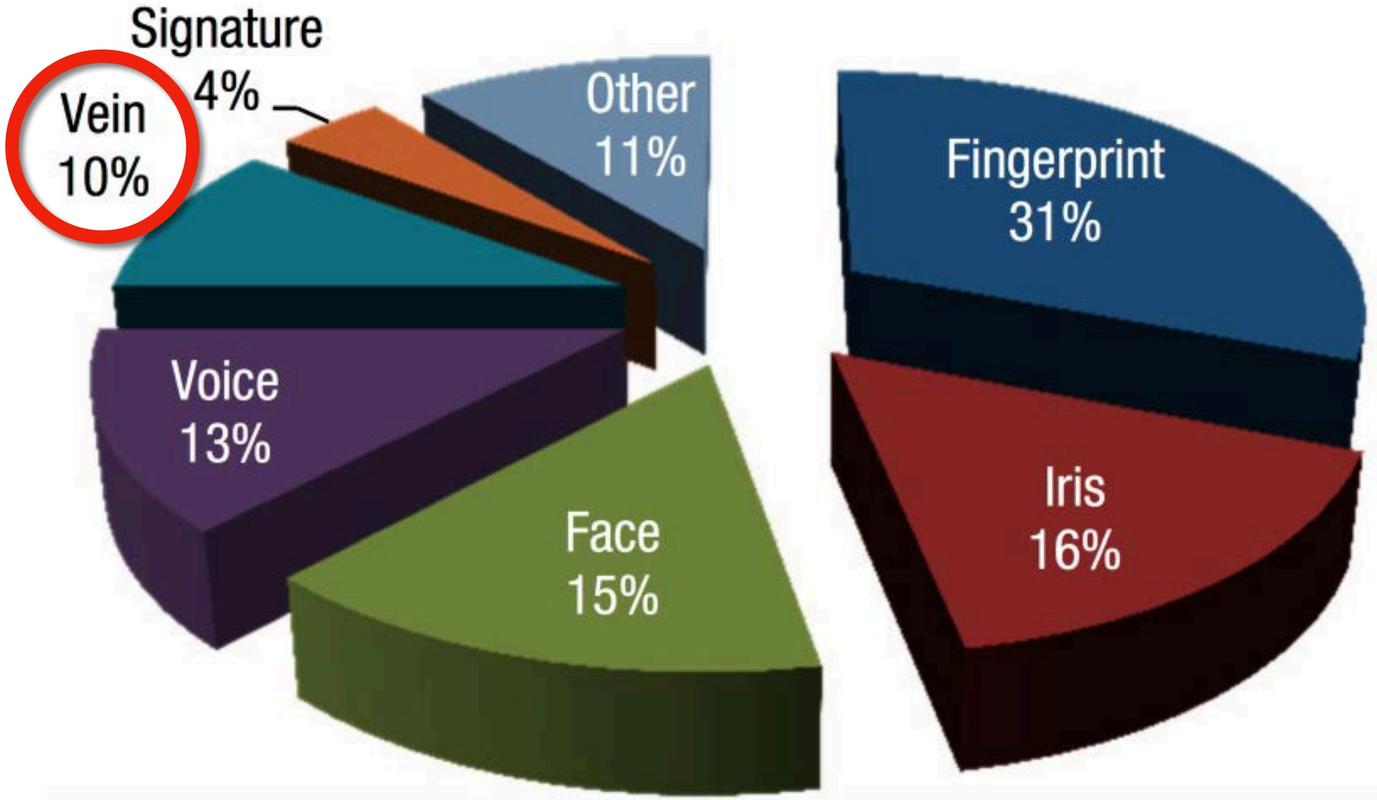
A New Era of Presentation Attack



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.

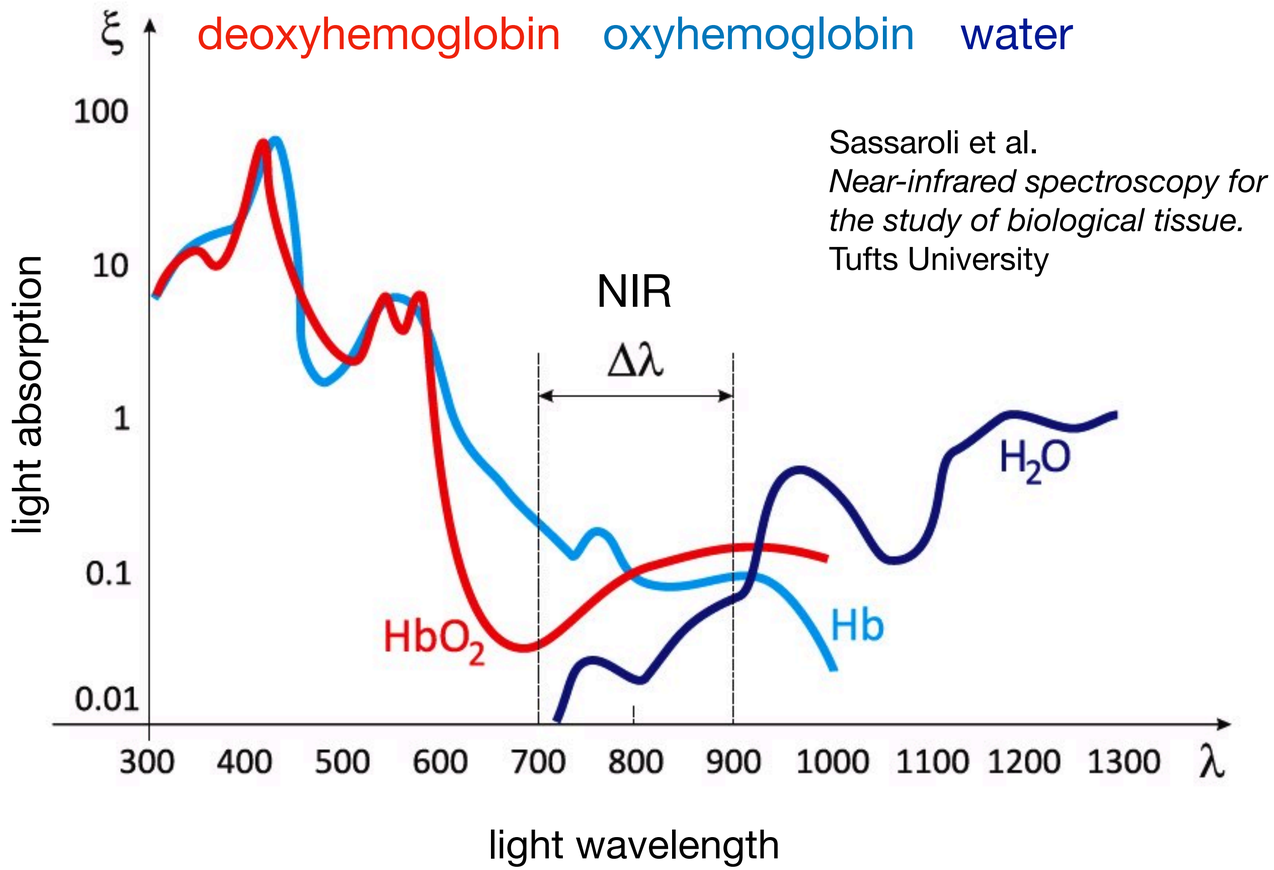
Dr. Adam Czajka

Hitachi
Finger Vein Authentication
White Paper, 2004

Vein Recognition

Acquisition

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



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

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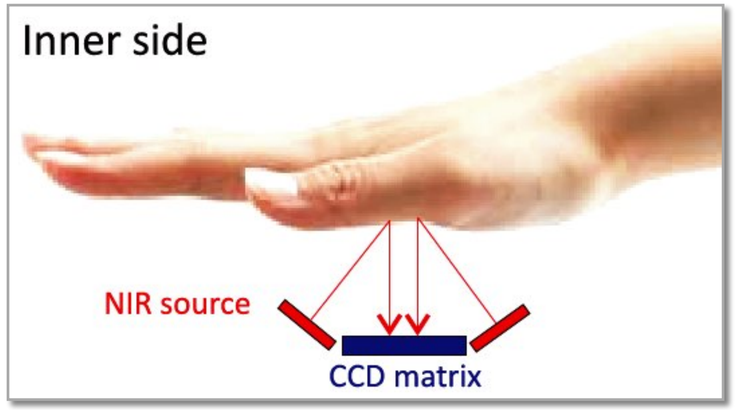
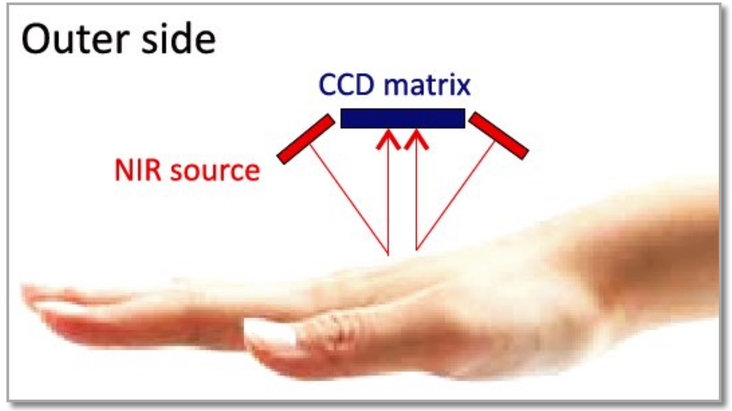
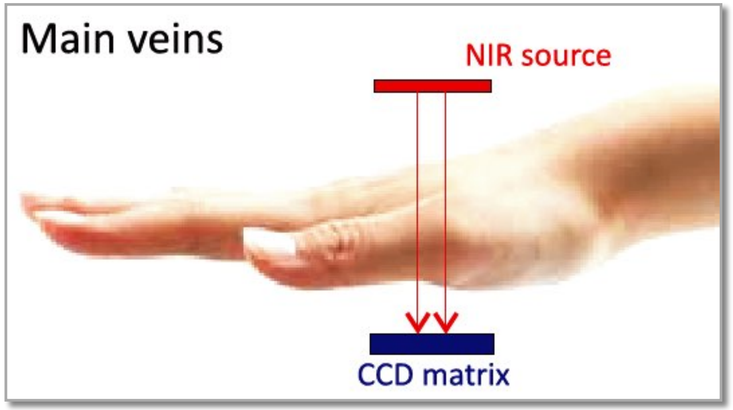
Vein Recognition

Palm Vein Acquisition







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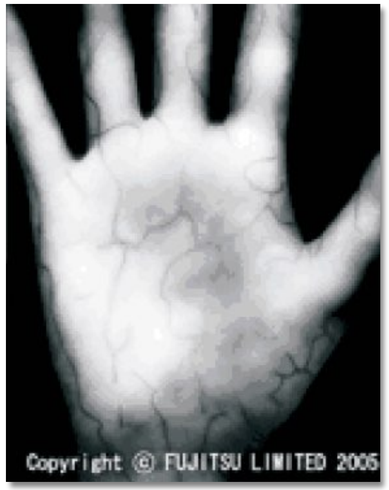
Vein Recognition

Palm Vein Acquisition

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

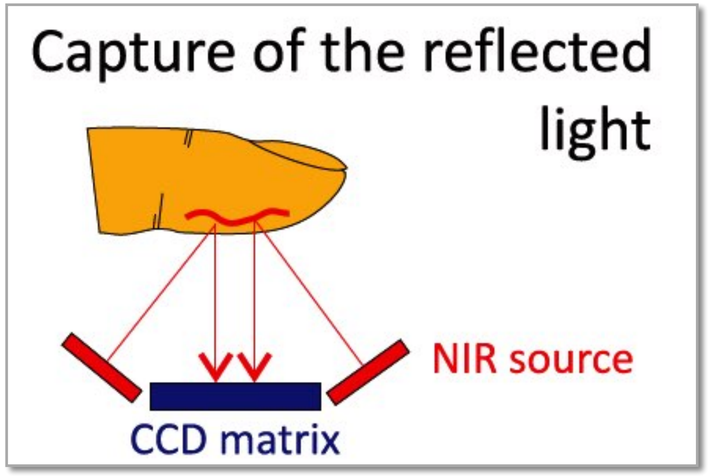


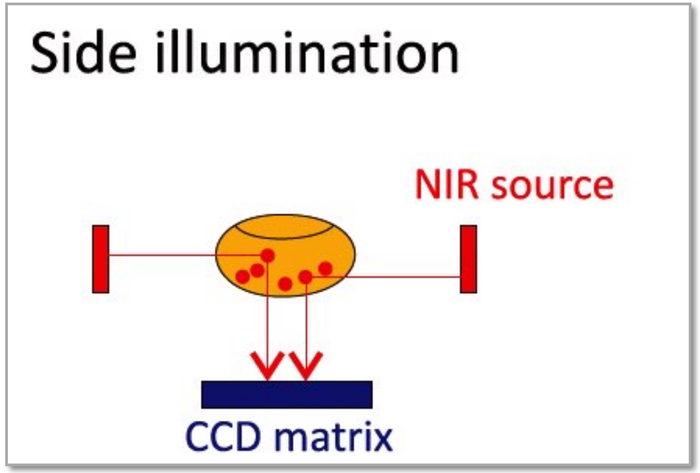
Fujitsu PalmSecure reader

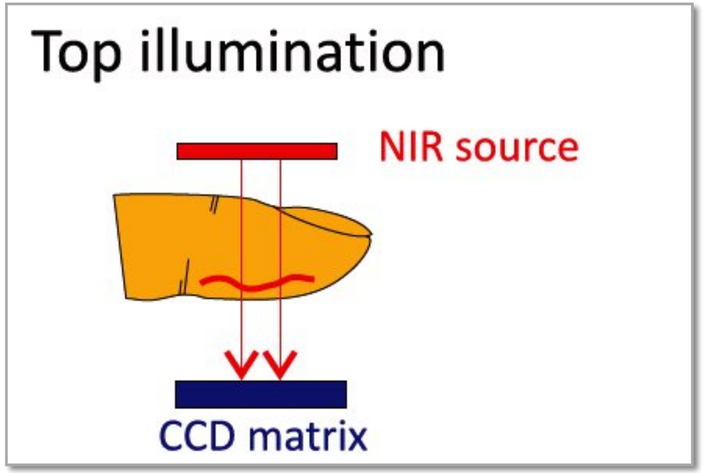
Techsphere VP II reader

Vein Recognition

Finger Vein Acquisition







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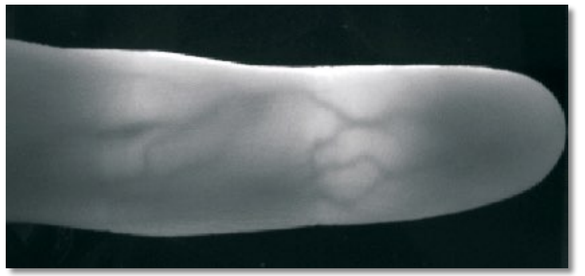
Vein Recognition

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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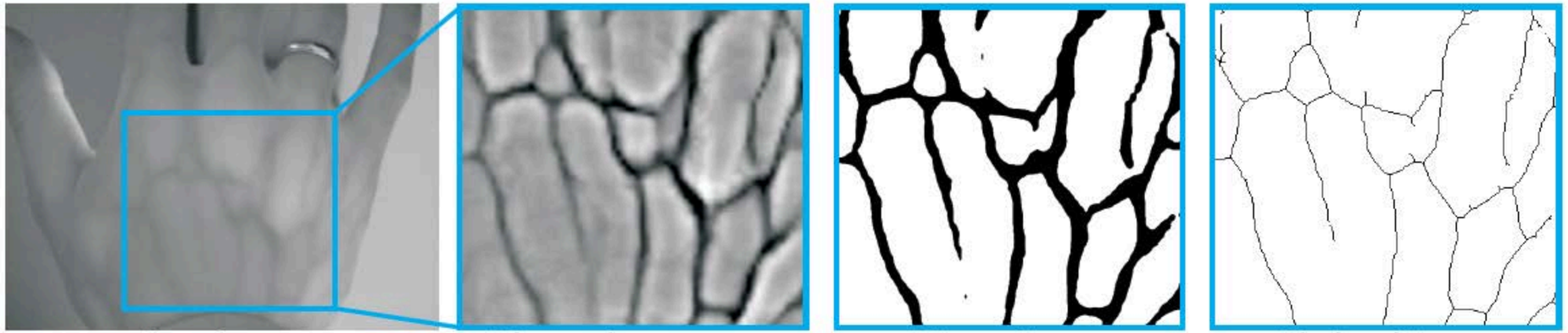


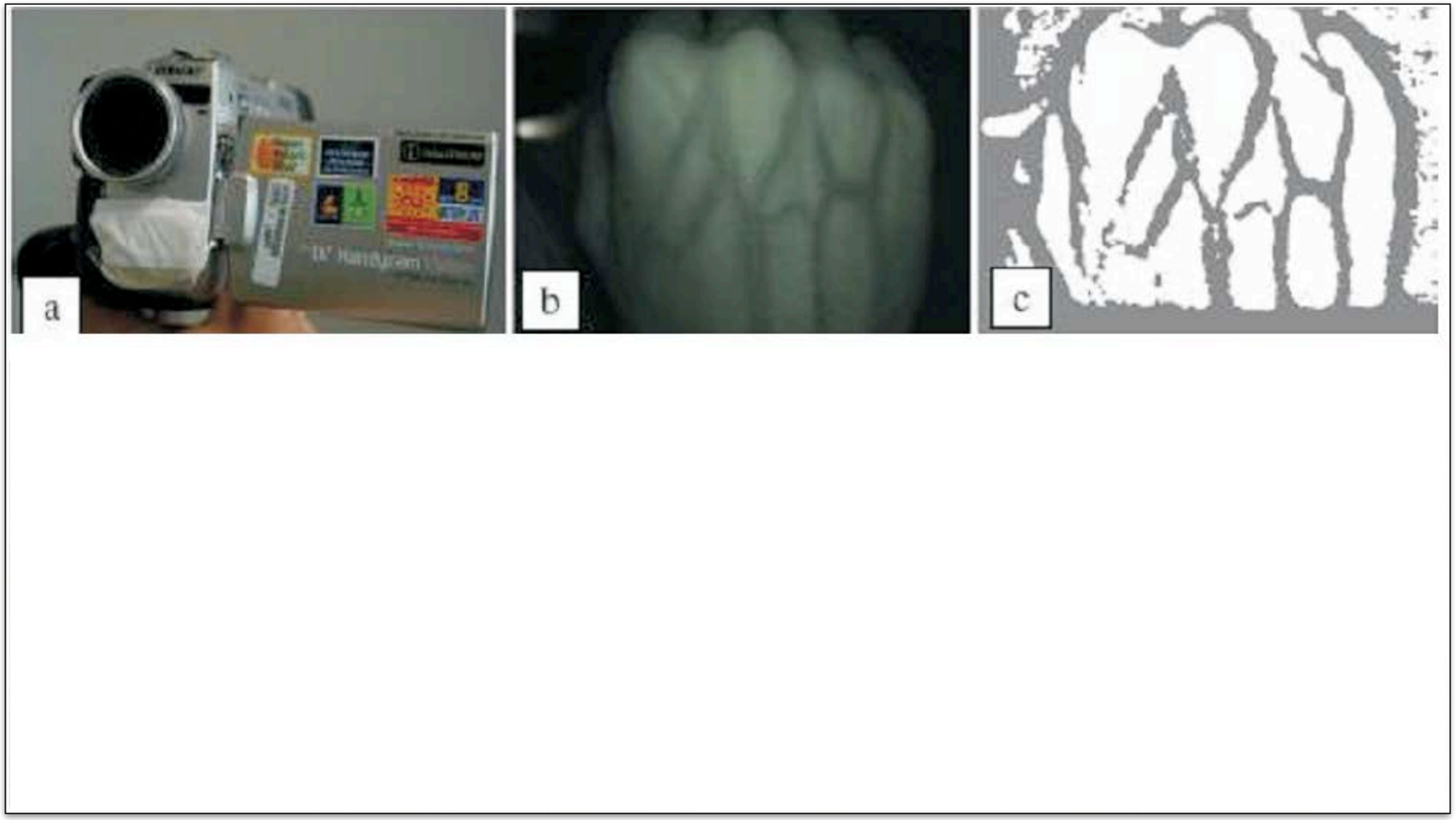
Vein Recognition

Vein Description Strategies

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

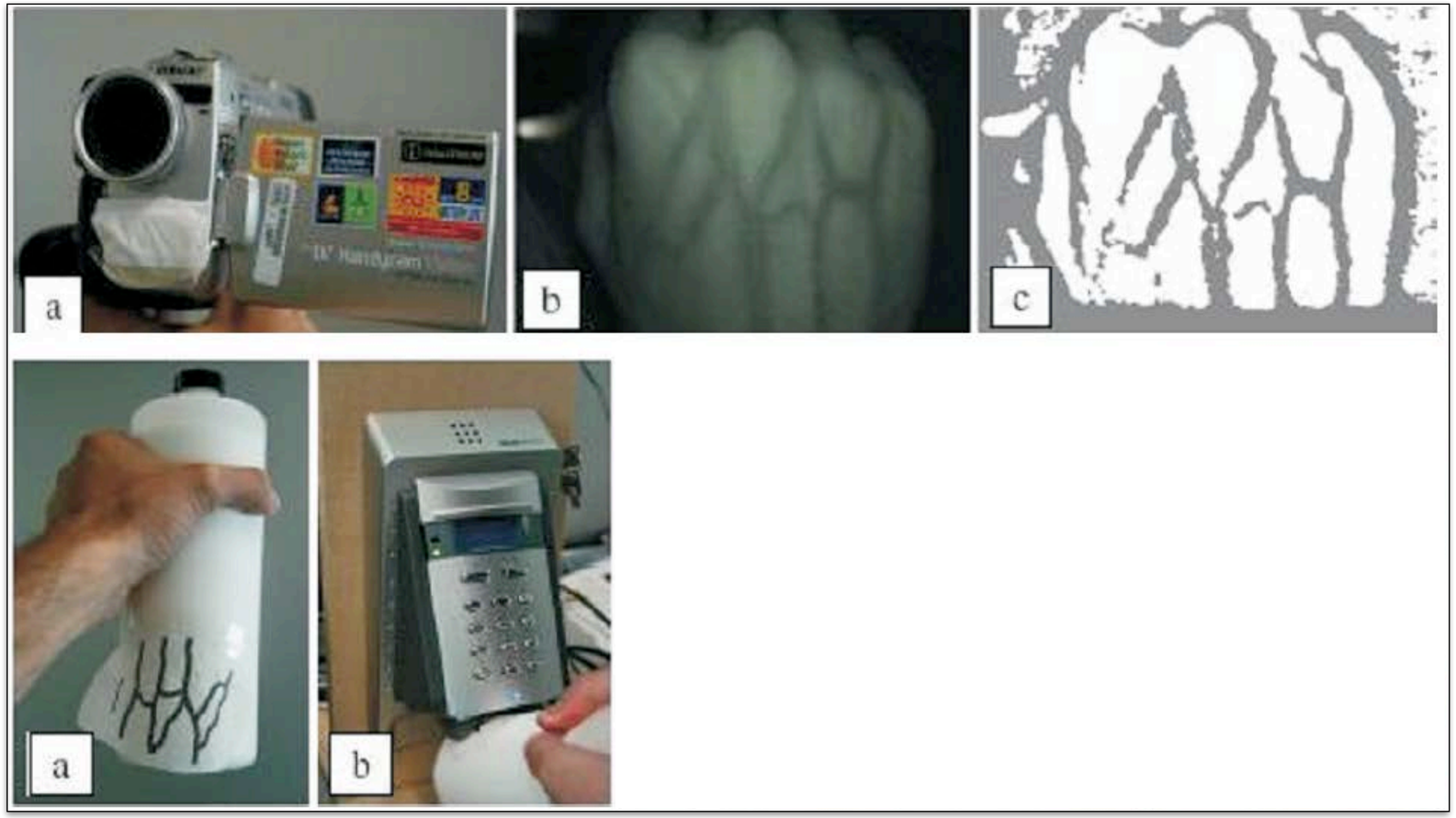
Vein Recognition

Presentation Attack



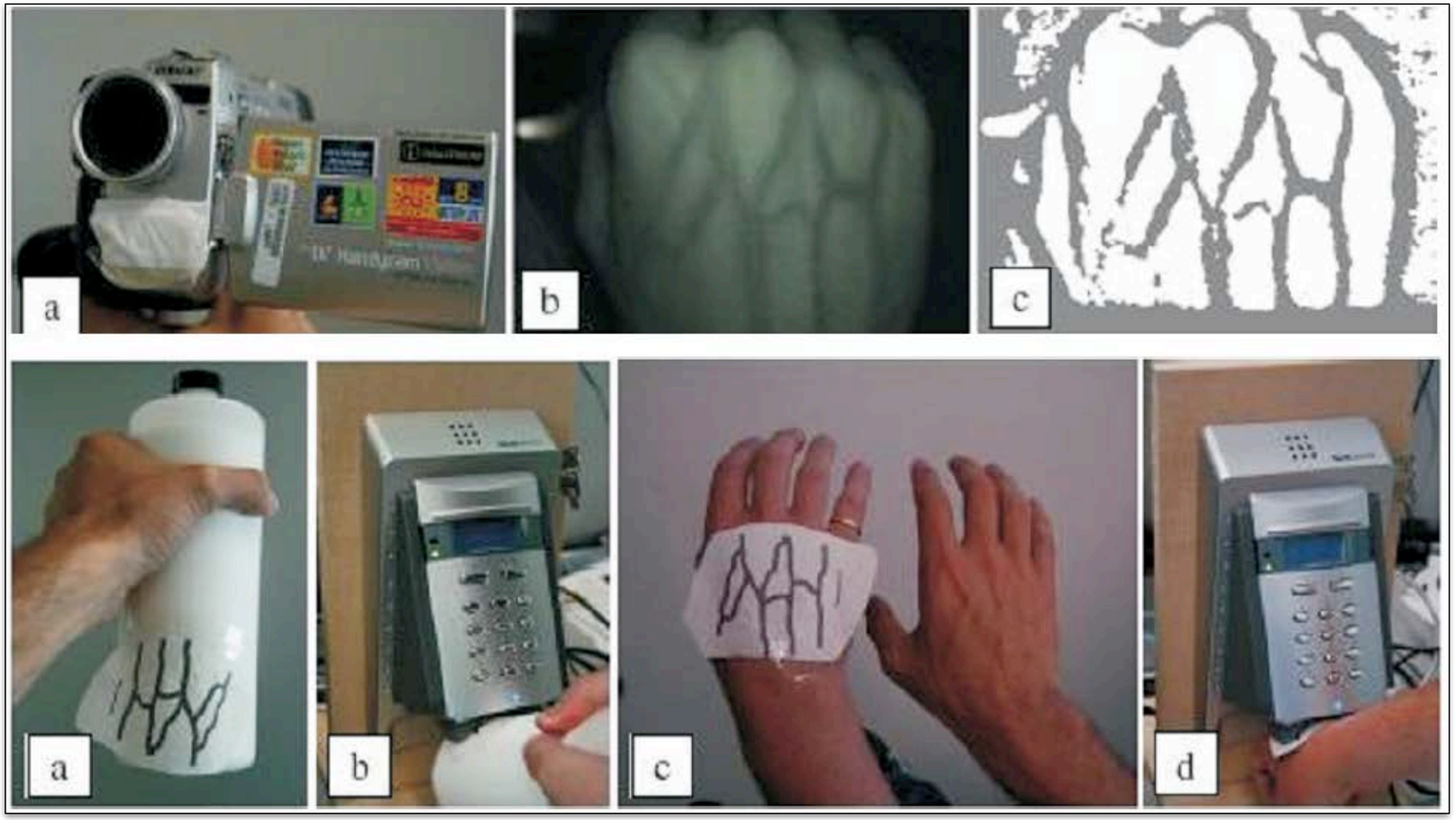
Vein Recognition

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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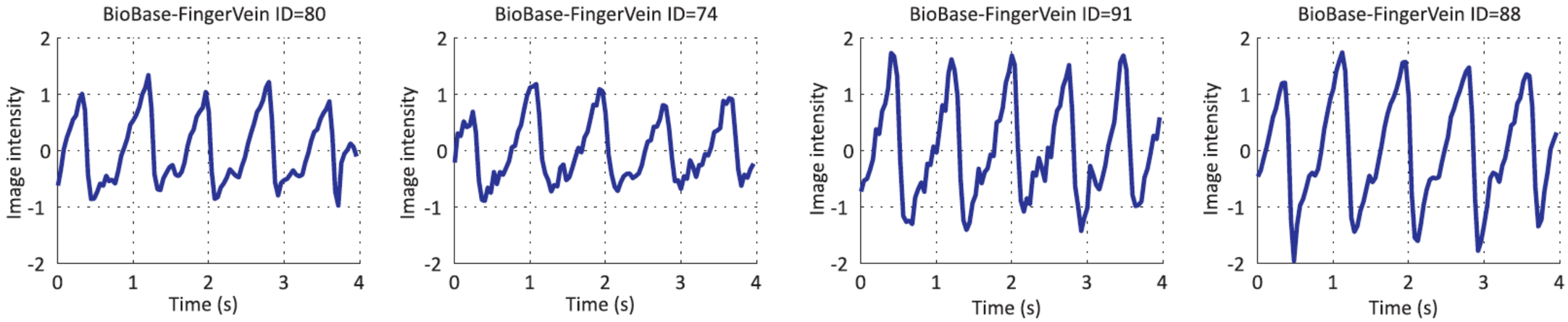

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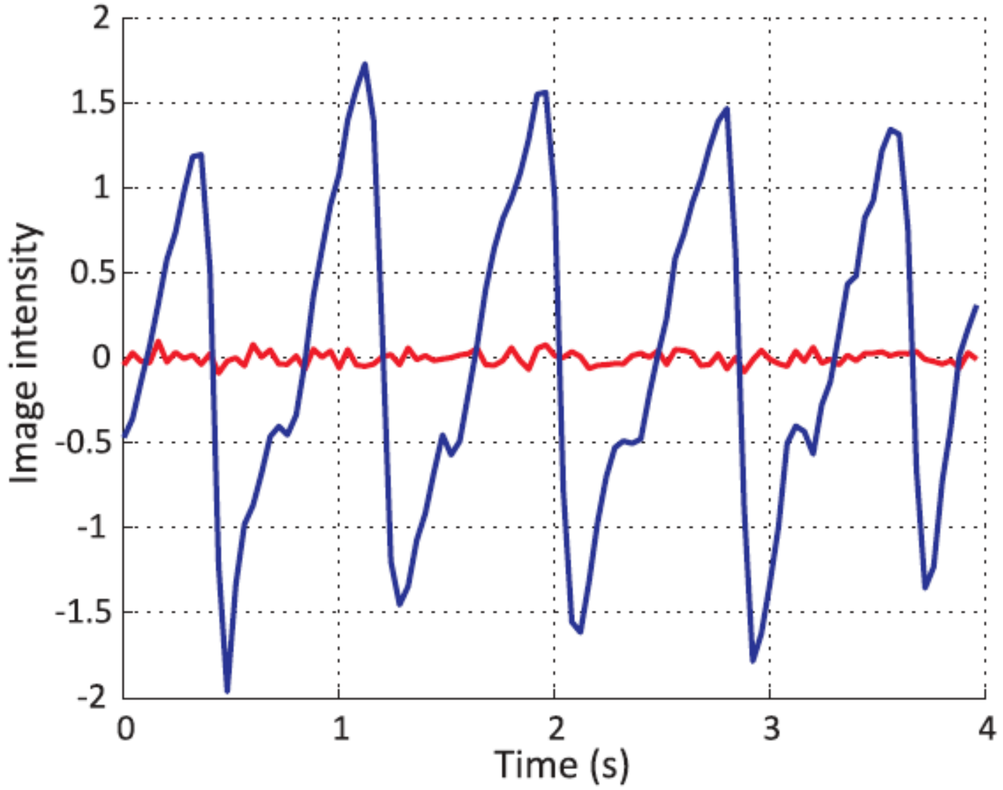
Vein Recognition

Presentation Attack Detection

Blood Pulse Detection



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Forgery

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Vein Recognition

Presentation Attack Detection

Temperature Measurement

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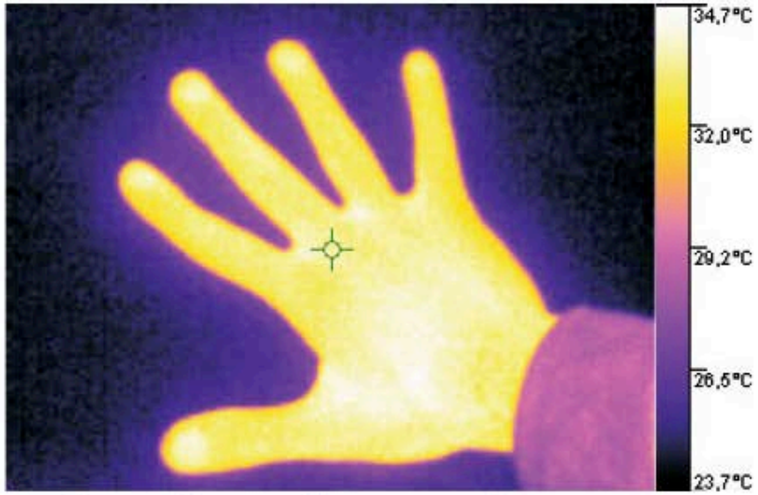
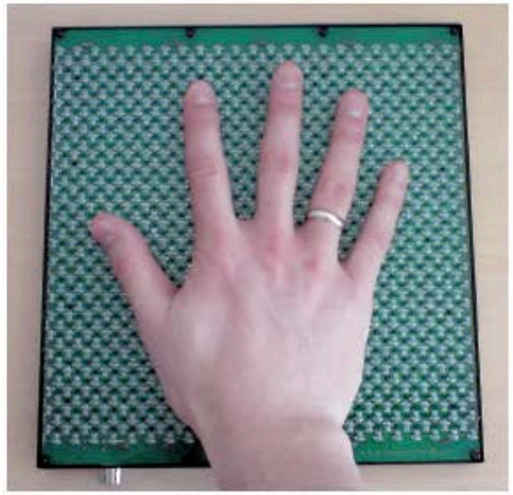
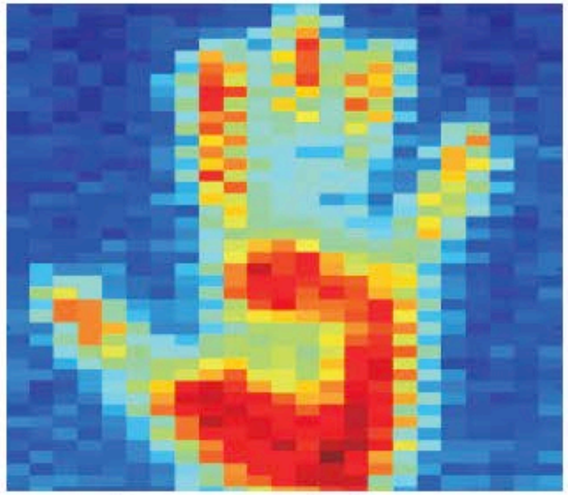


Raw thermal camera image


Matrix of thermal sensors


Raw matrix image

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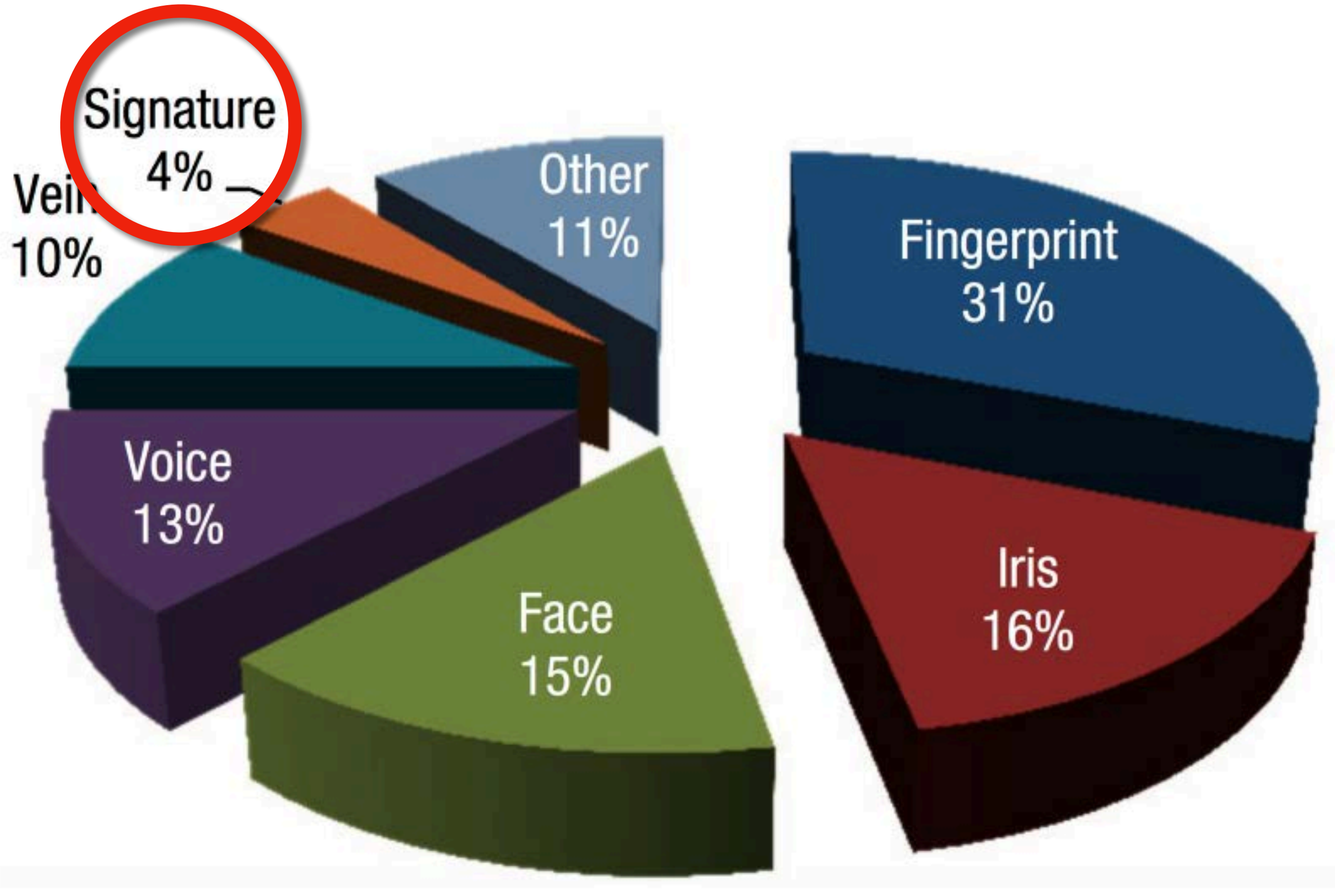
Alternative Traits

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=Y1449tOo7Xw

Signature Recognition

Off-line Acquisition

Based on visual content only.

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

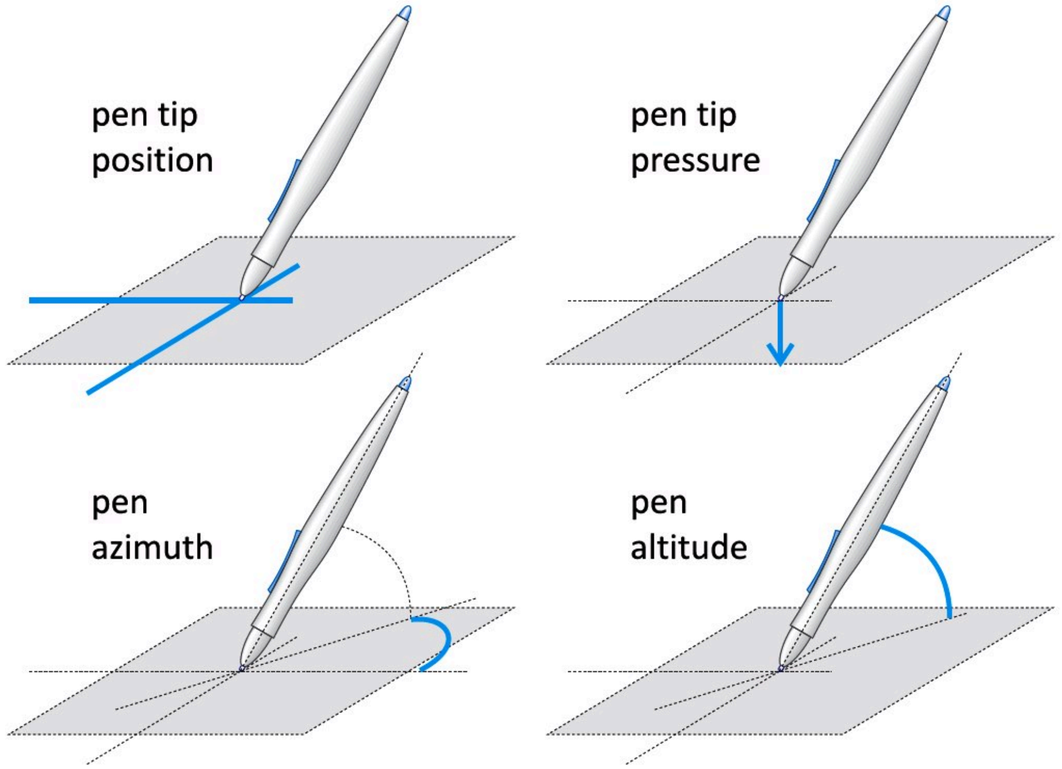
Not necessarily aided by a computer.

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

Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.



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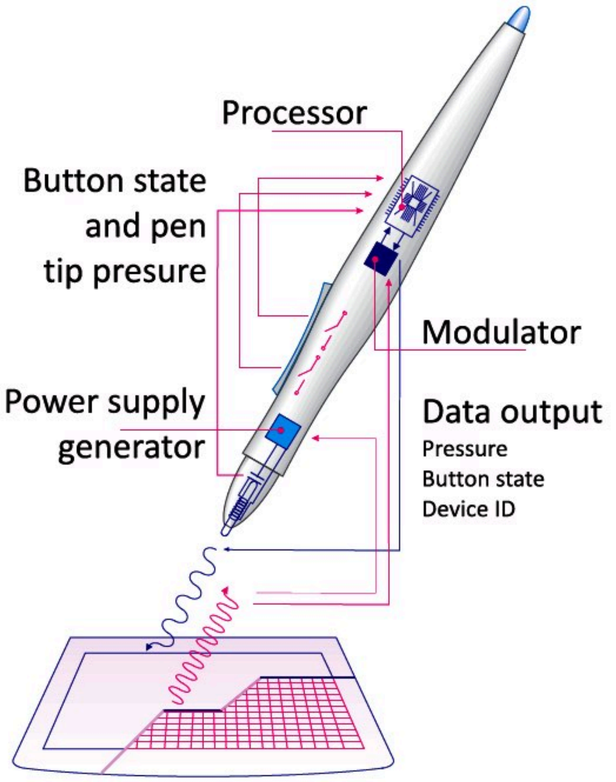
Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.

Special sensors
(such as digitizing tablets).



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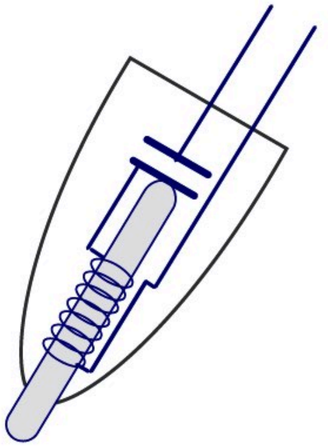

Inductor-capacitor circuit (LC circuit)

Signature Recognition

On-line Acquisition

Various components are captured
from the signing behavior.

Special sensors
(such as digitizing tablets).

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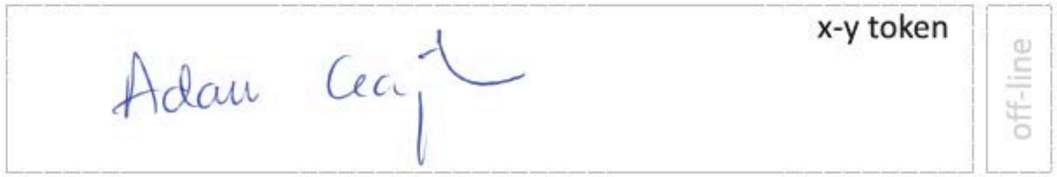
Aided by computer
(*acquisition*, *enhancement*, *feature extraction*, *matching*, *decision*).

Signature Recognition

On-line Acquisition

Signature Tokens



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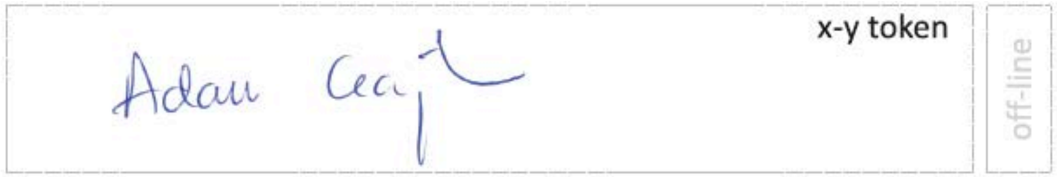
Signature Recognition

On-line Acquisition

Signature Tokens



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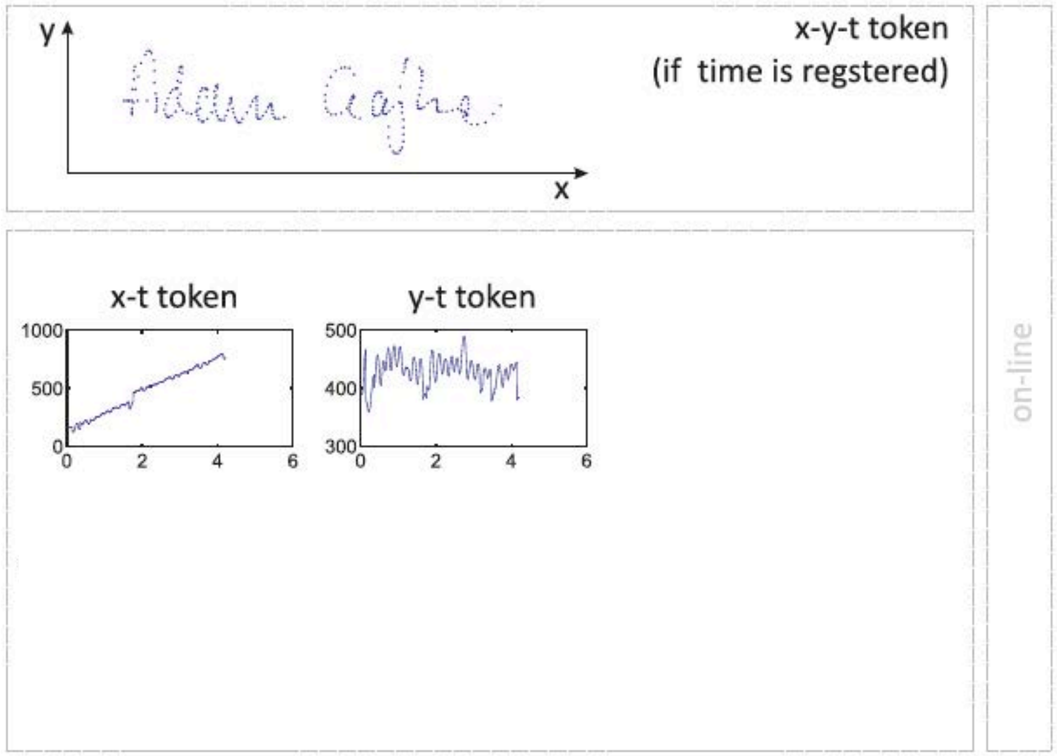

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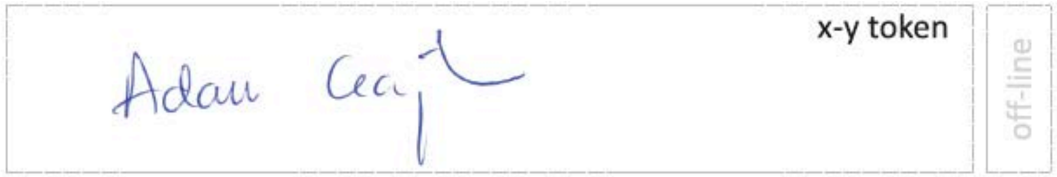
Signature Recognition

On-line Acquisition

Signature Tokens



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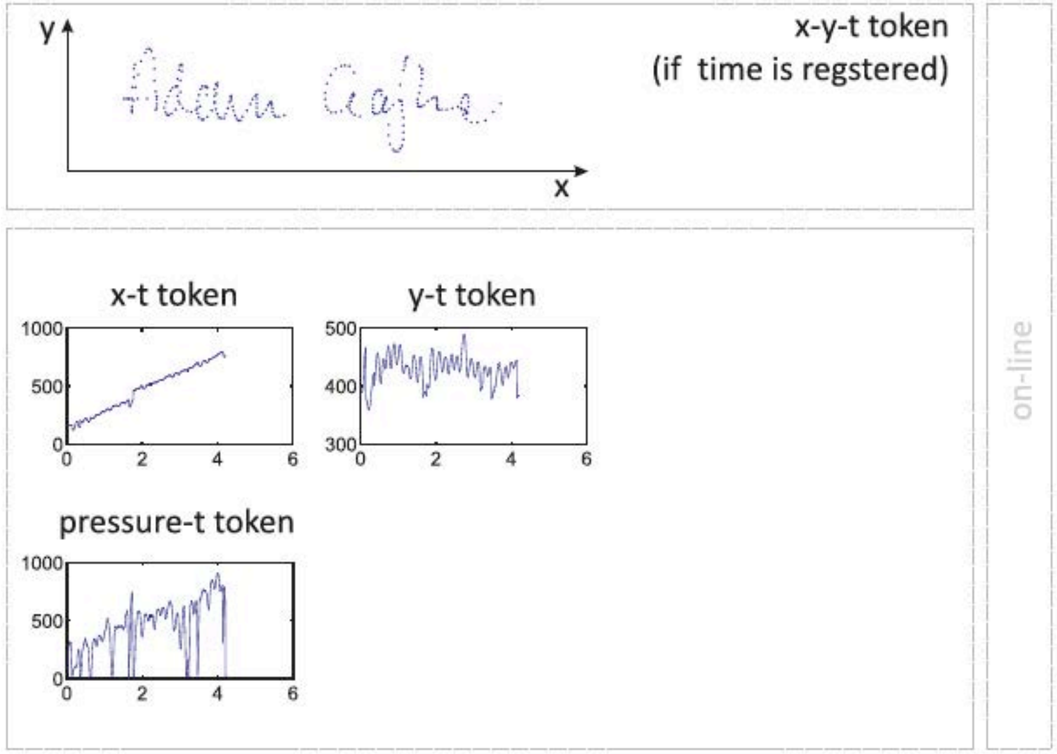

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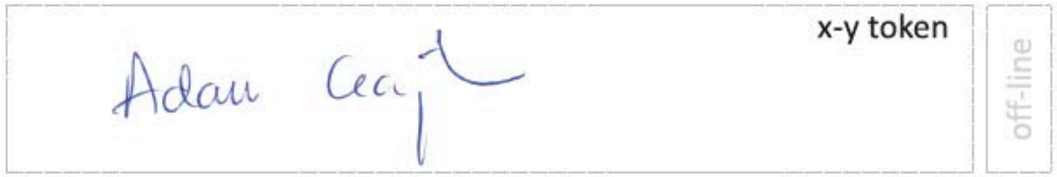
Signature Recognition

On-line Acquisition

Signature Tokens



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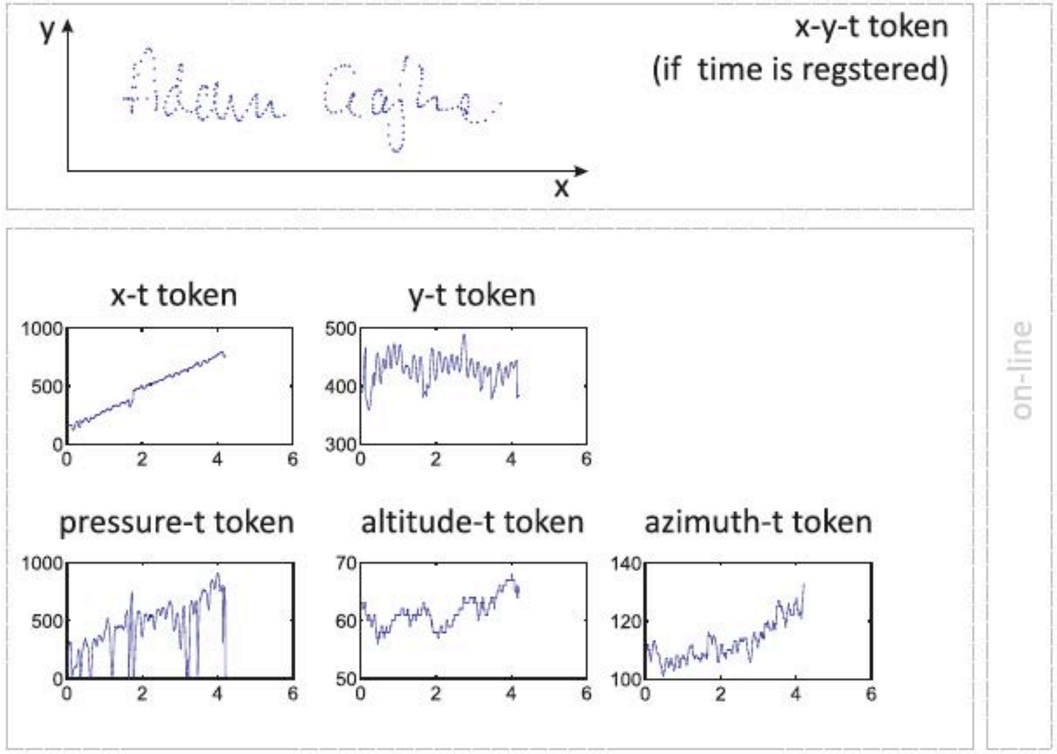
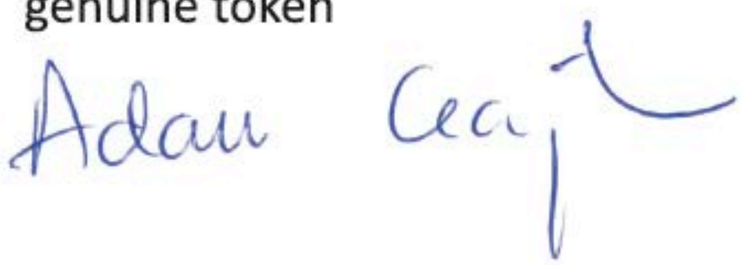


Signature Recognition

Presentation Attack

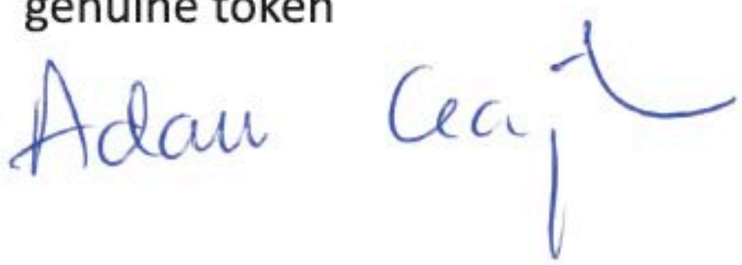
genuine token



Signature Recognition

Presentation Attack

genuine token



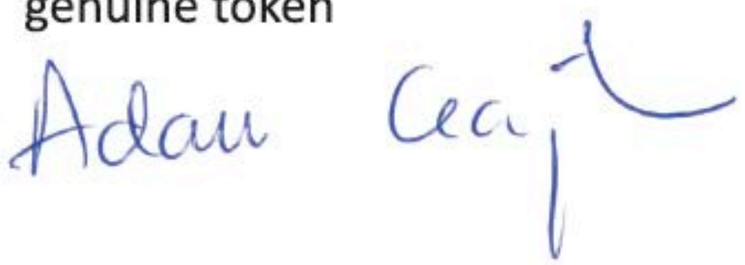
Whatever, dude.

random forgery

Signature Recognition

Presentation Attack

genuine token



simple forgery

I know your name.

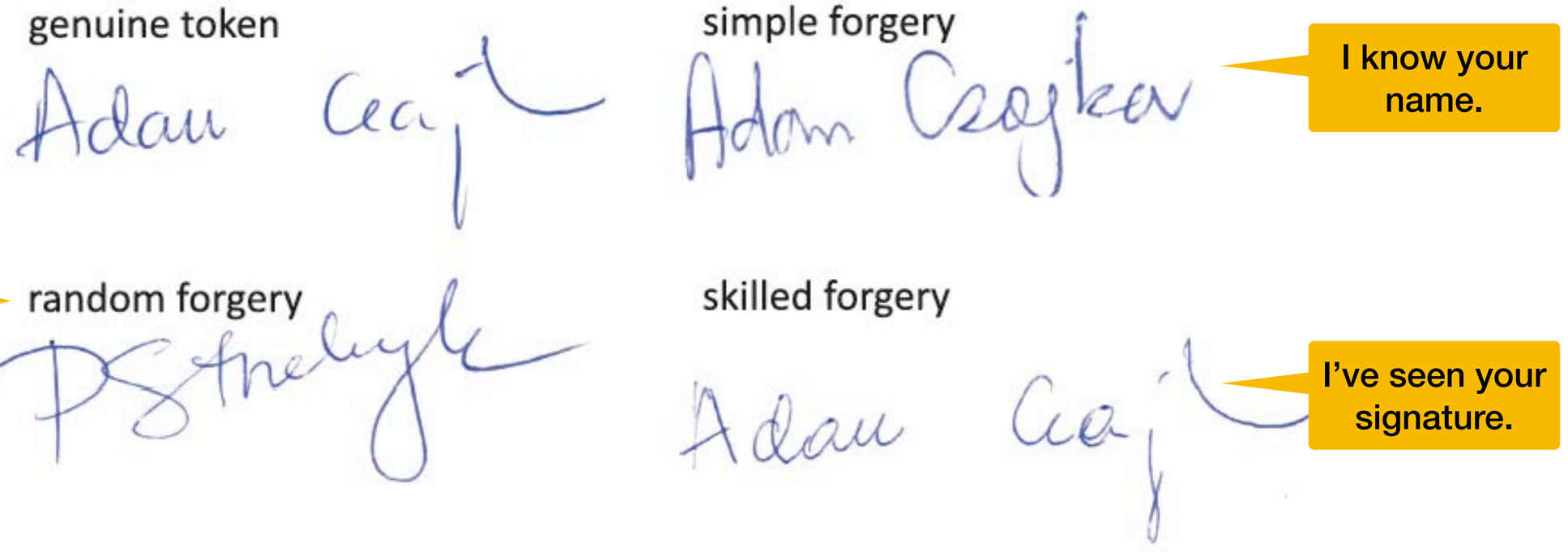
Whatever, dude.

random forgery

Signature Recognition

Presentation Attack

Dr. Adam Czajka



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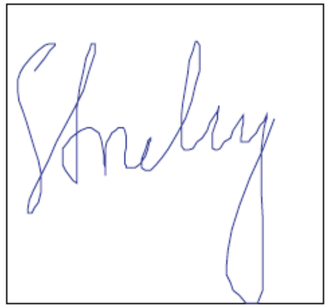
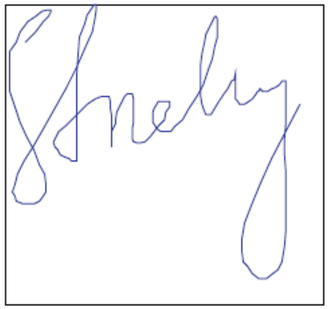
Signature Recognition

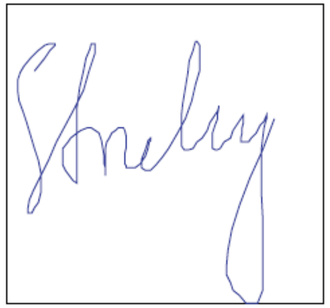
Presentation Attack Detection

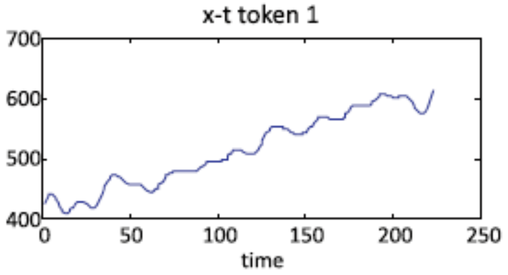


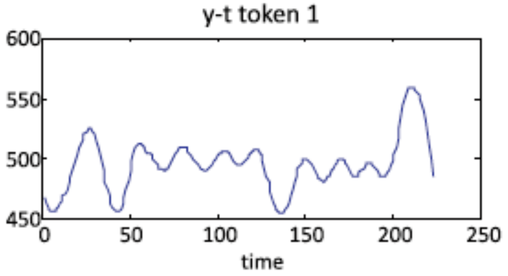


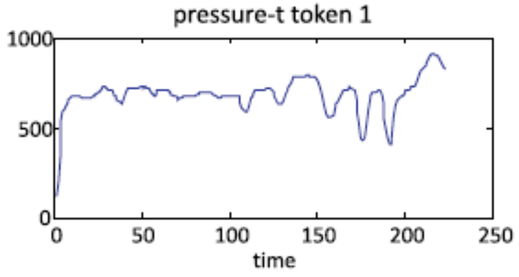
Signature Recognition

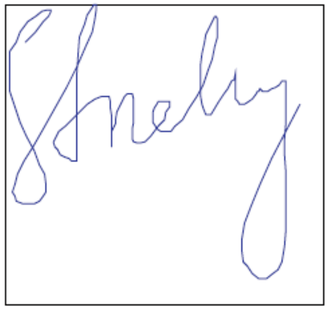
Presentation Attack Detection











Signature Recognition

Presentation Attack Detection

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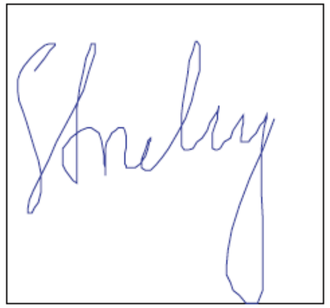
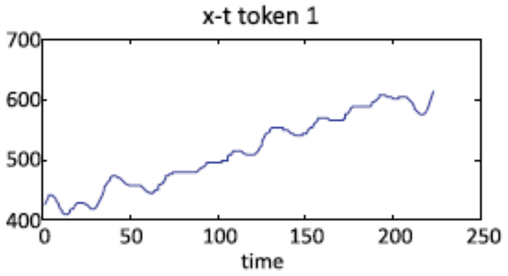
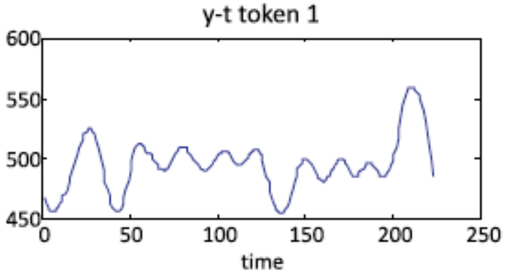
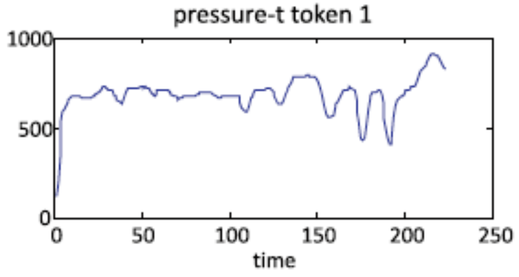
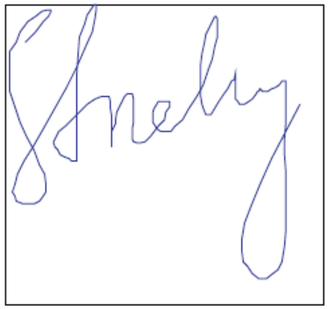
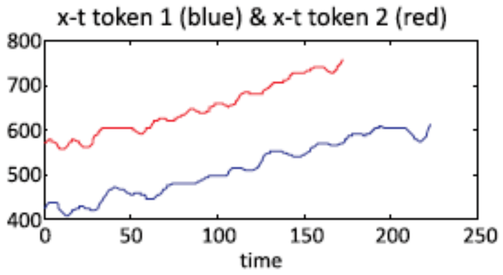


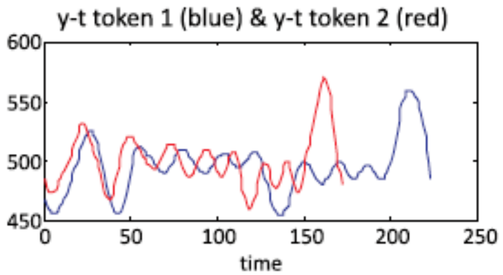


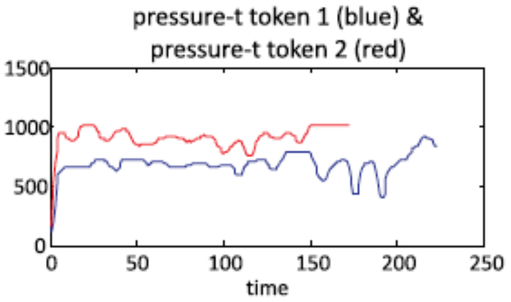






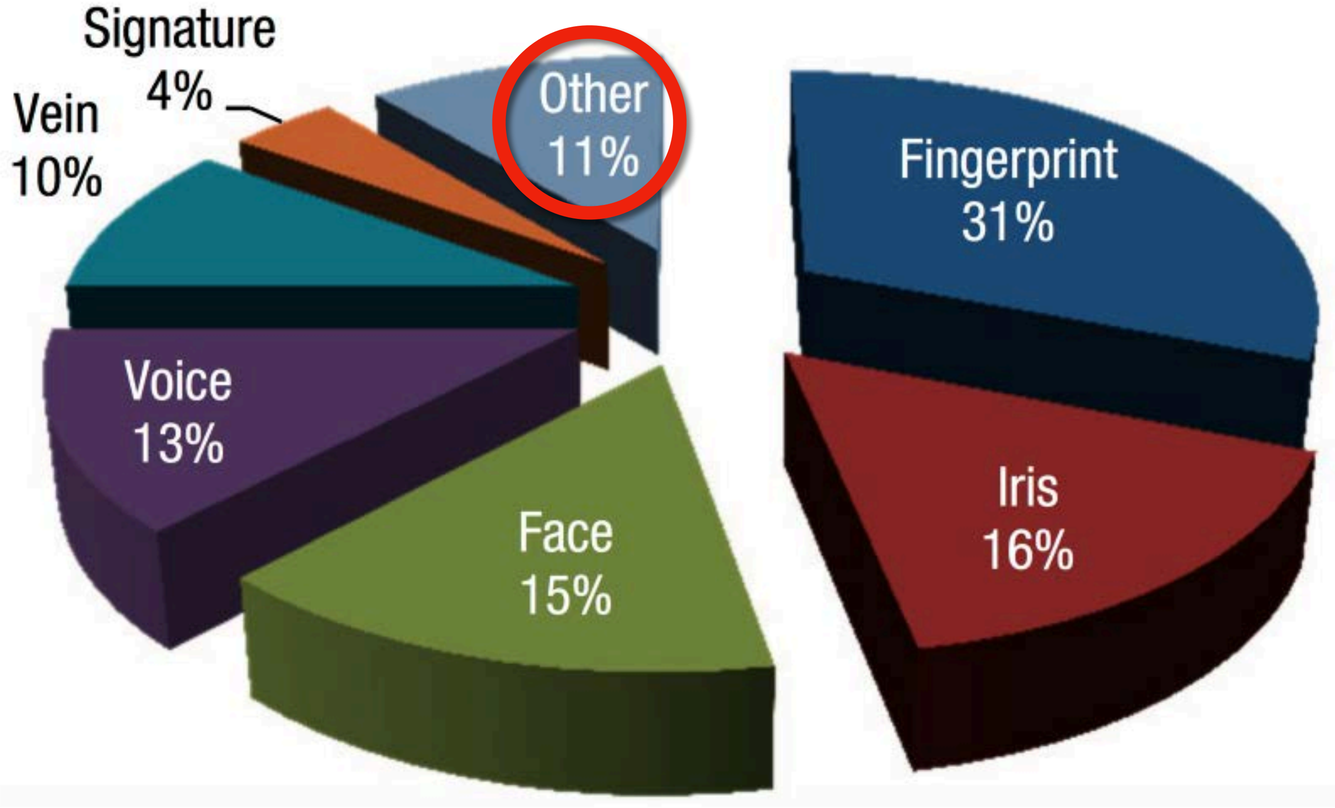






Alternative Traits

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.

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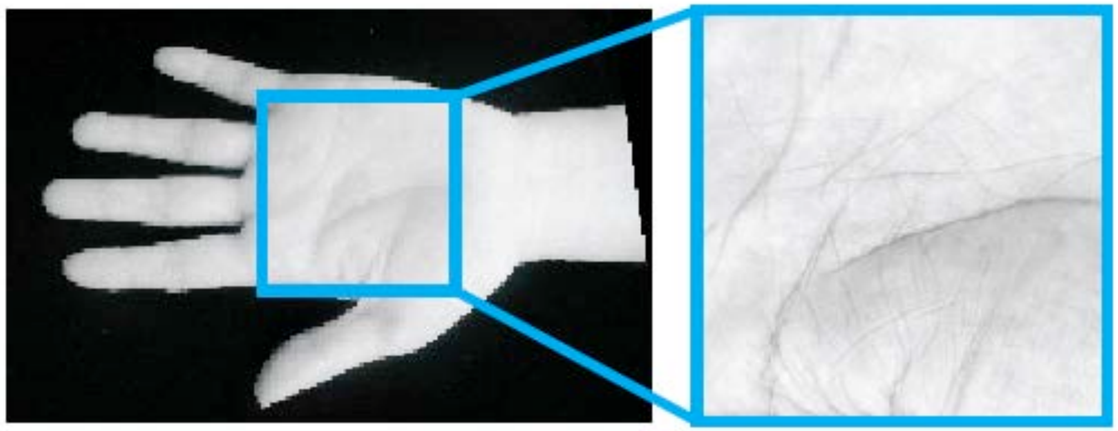


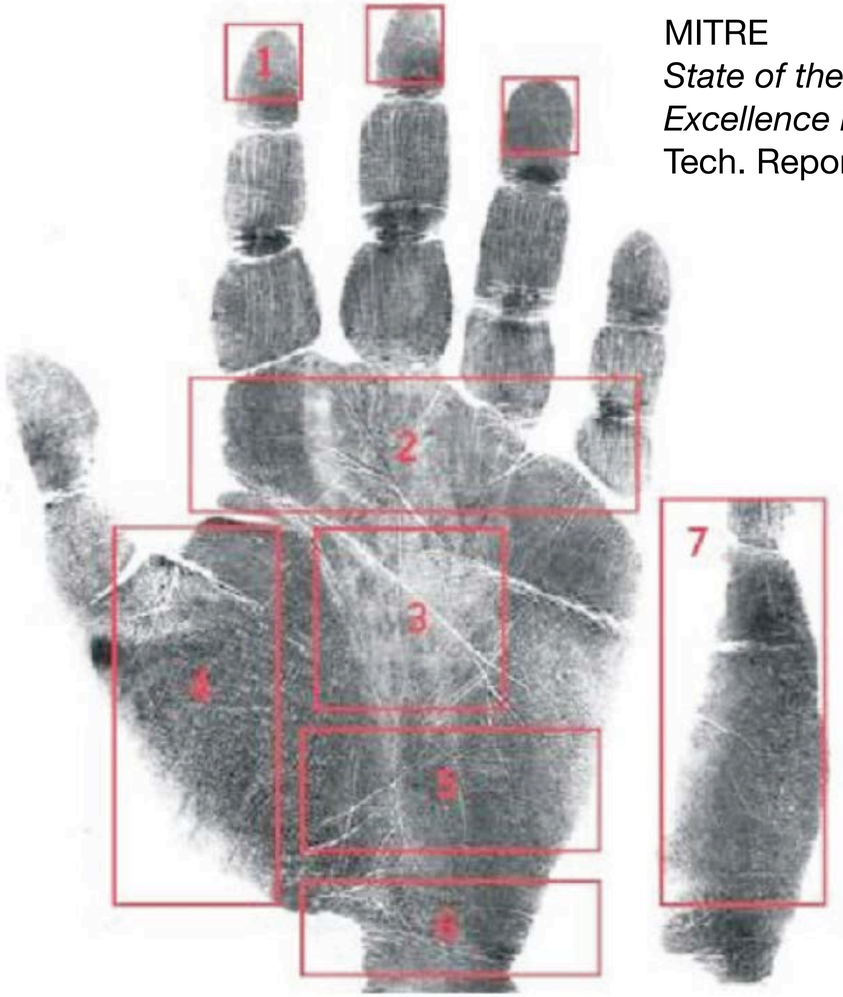
Palmprint Recognition

Level-2 Features

Minutiae

Ridge endings and bifurcations (position and angle).

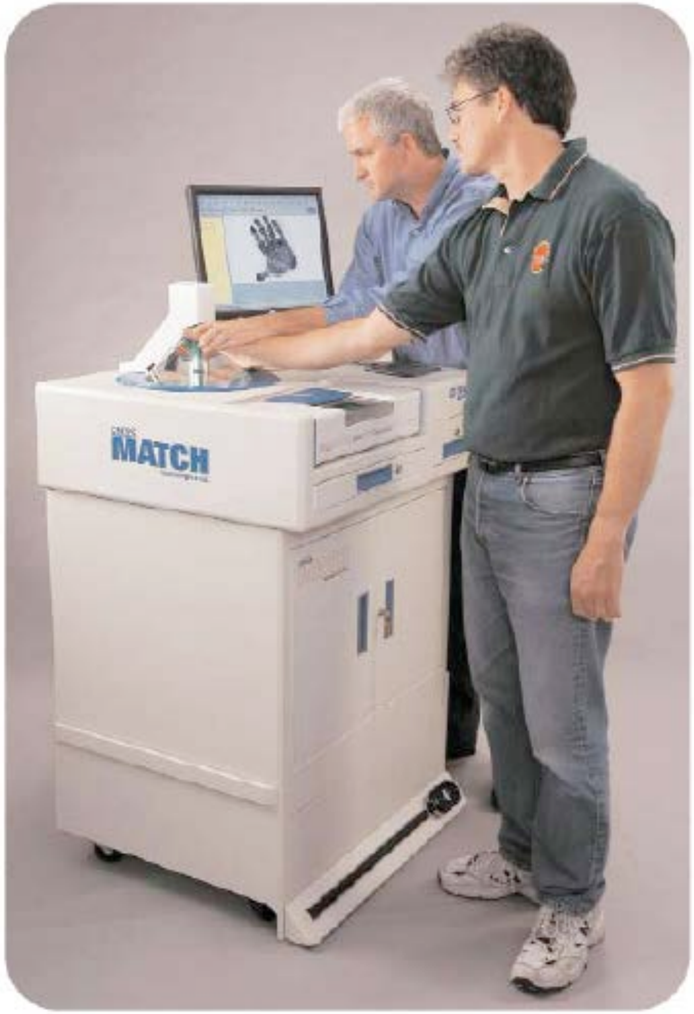
Focus on the inner and side portion of the hand.



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

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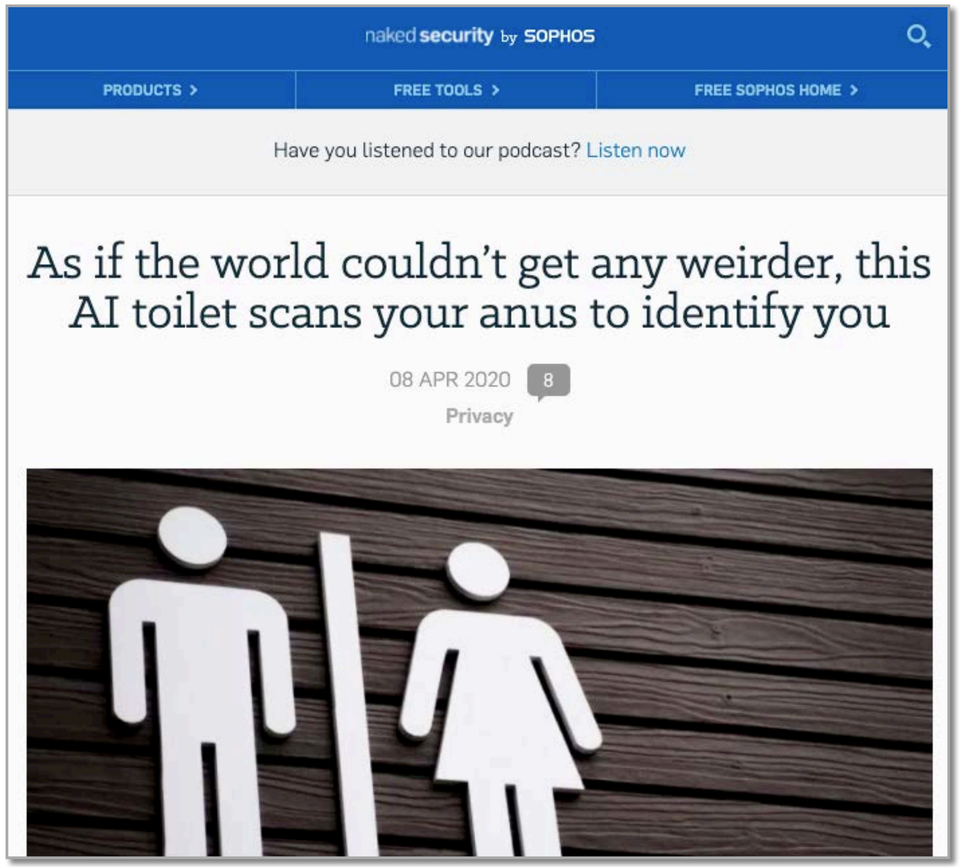
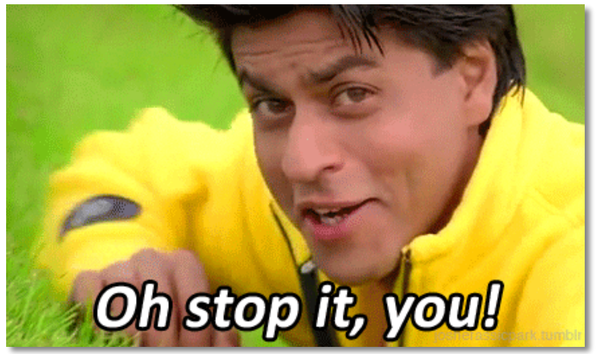
Other Traits

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/



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Soft Biometrics

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

Soft Biometrics

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

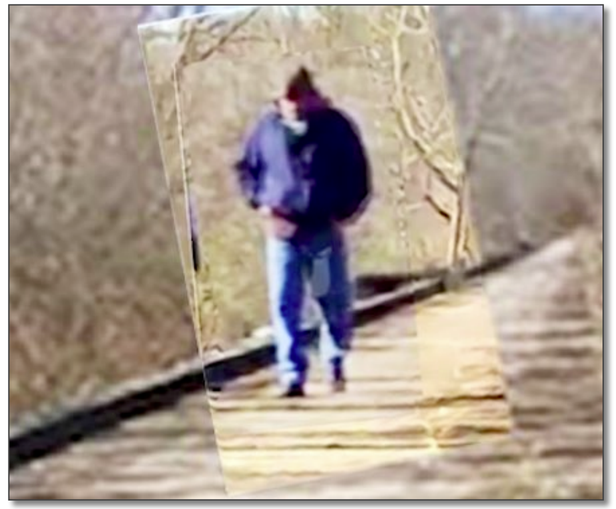
Benefits
Recognition accuracy improvement
Recognition runtime reduction

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



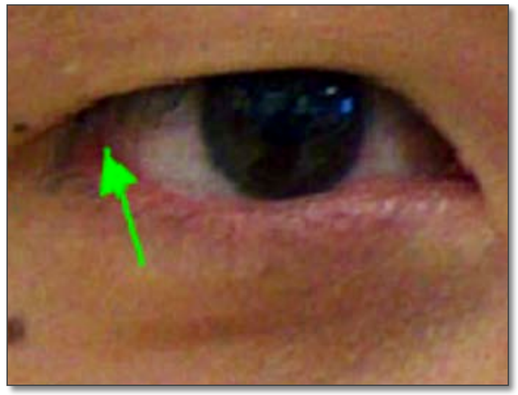
https://bit.ly/3u81gXd

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

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

moles, scars, marks

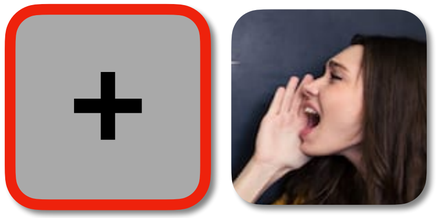
birthmarks

tattoos

What's Next?

Fusion (a.k.a. Multibiometrics)

Fill out your
Today-I-missed Statement
Please visit sakai.luc.edu/x/BCJs8K.



Alternative Traits and
Fusion
Concepts

Invited Talks (2)
State of the art
Future work