Other Traits

COMP 388-002/488-002 Biometrics

Daniel Moreira

Fall 2026

LOYOLA UNIVERSITY CHICAGO

Today we will…

Get to know
Alternative traits and
soft biometrics.

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UNIVERSITY CHICAGO

Today's Attendance

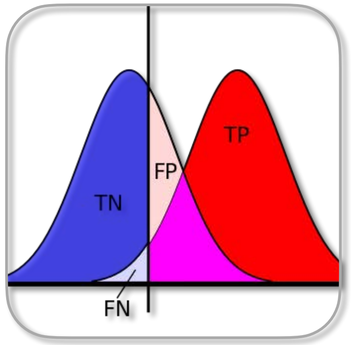
Please fill out the form

forms.gle/awXcxAfBXYmAJ9m99

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Course Overview

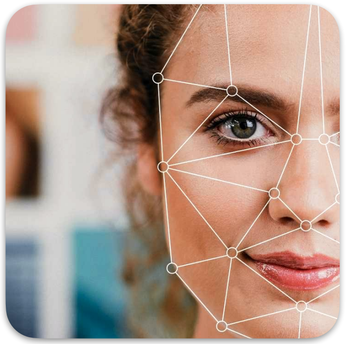
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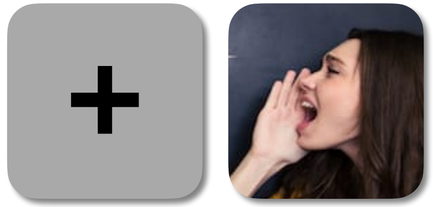
Basics
Concepts
Metrics
Metric implementation







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



Alternative Traits and Fusion
Concepts

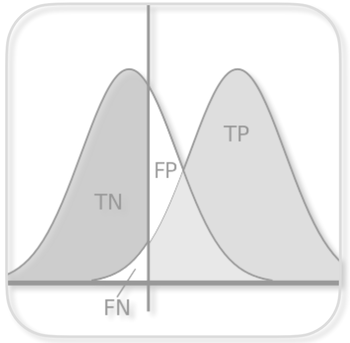


Invited Talks (2)
State of the art
Future work

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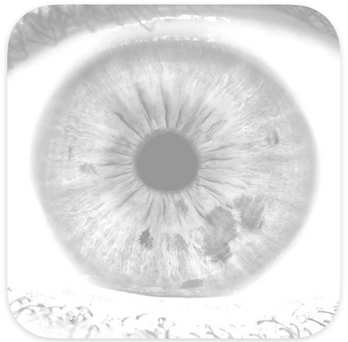
Course Overview

Content



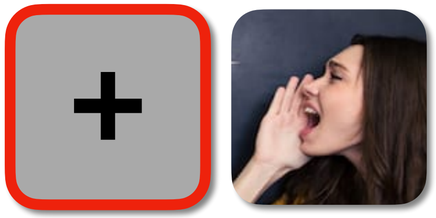
Basics
Concepts
Metrics
Metric implementation







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

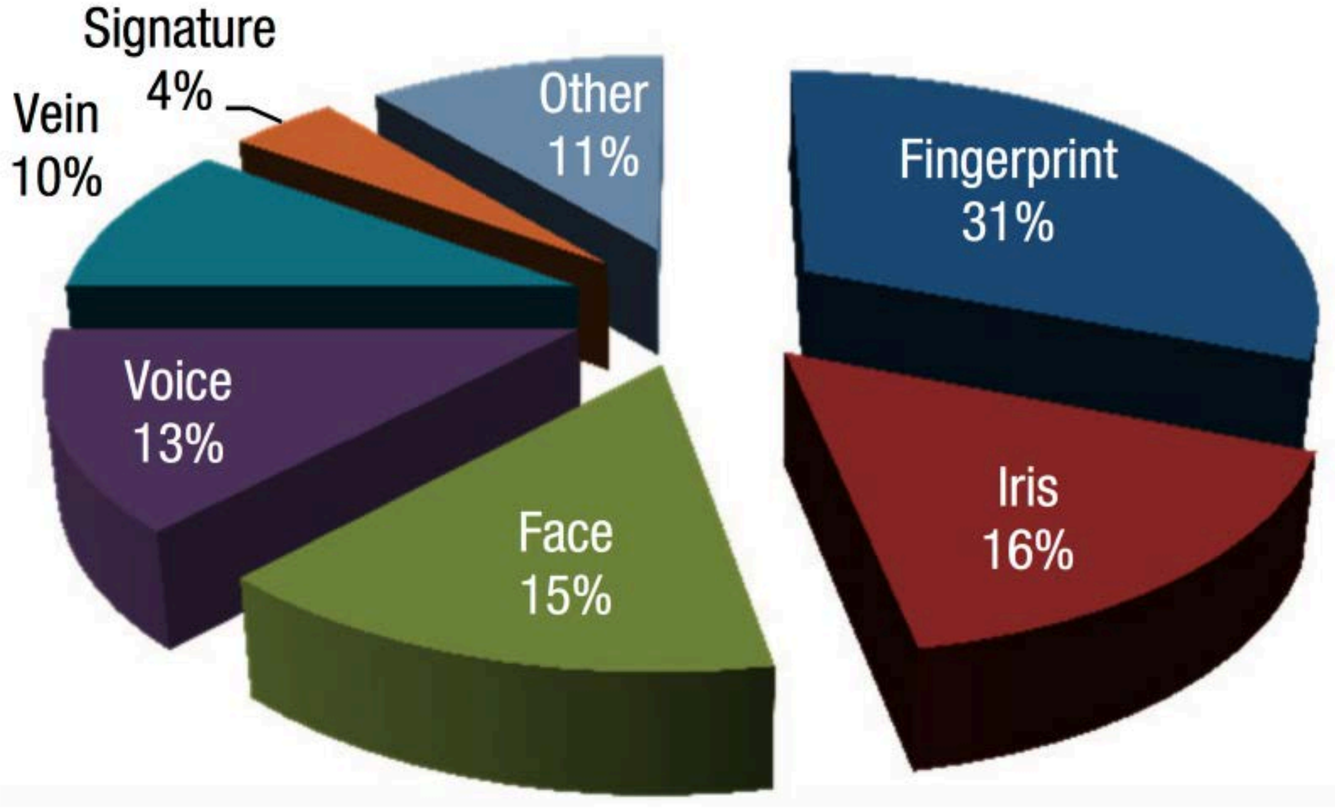


Invited Talks (2)
State of the art
Future work

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Alternative Traits

Market

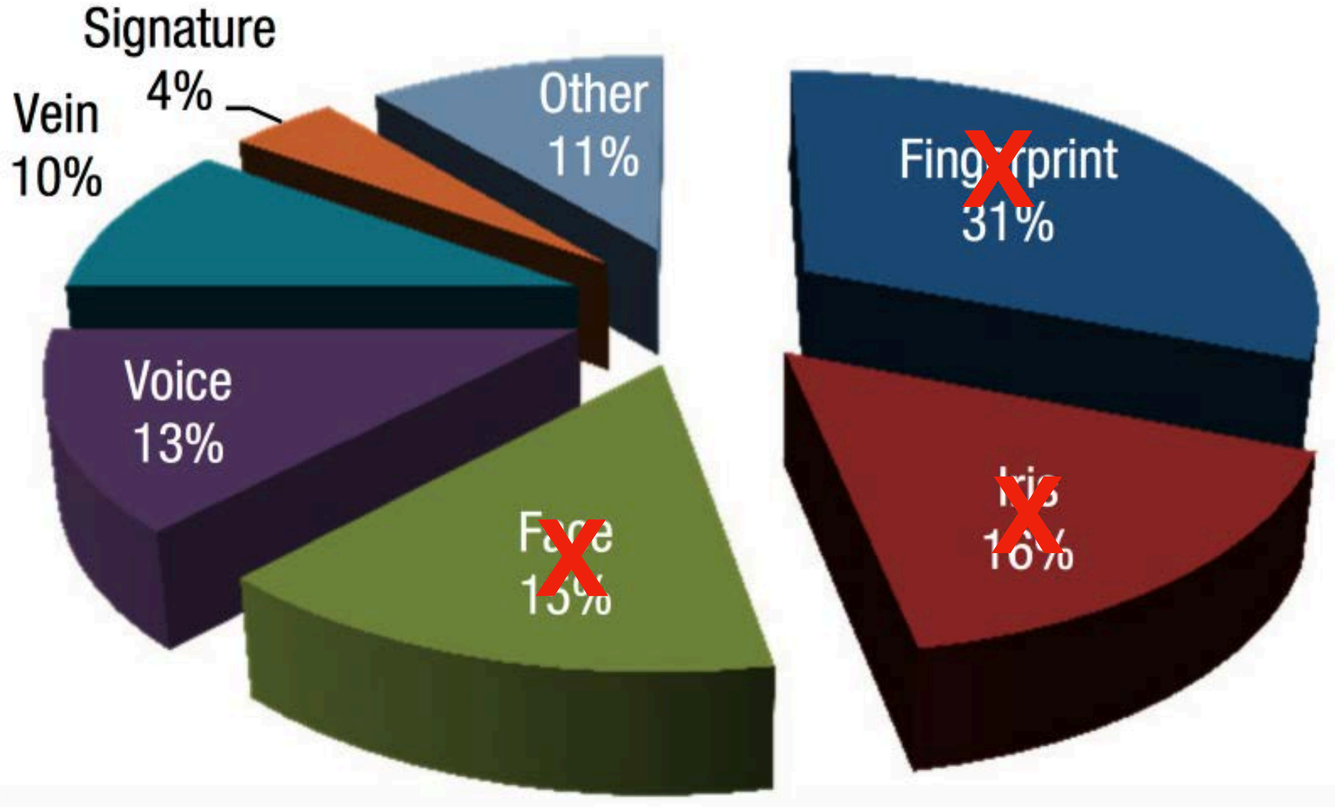


Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

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Alternative Traits

Market

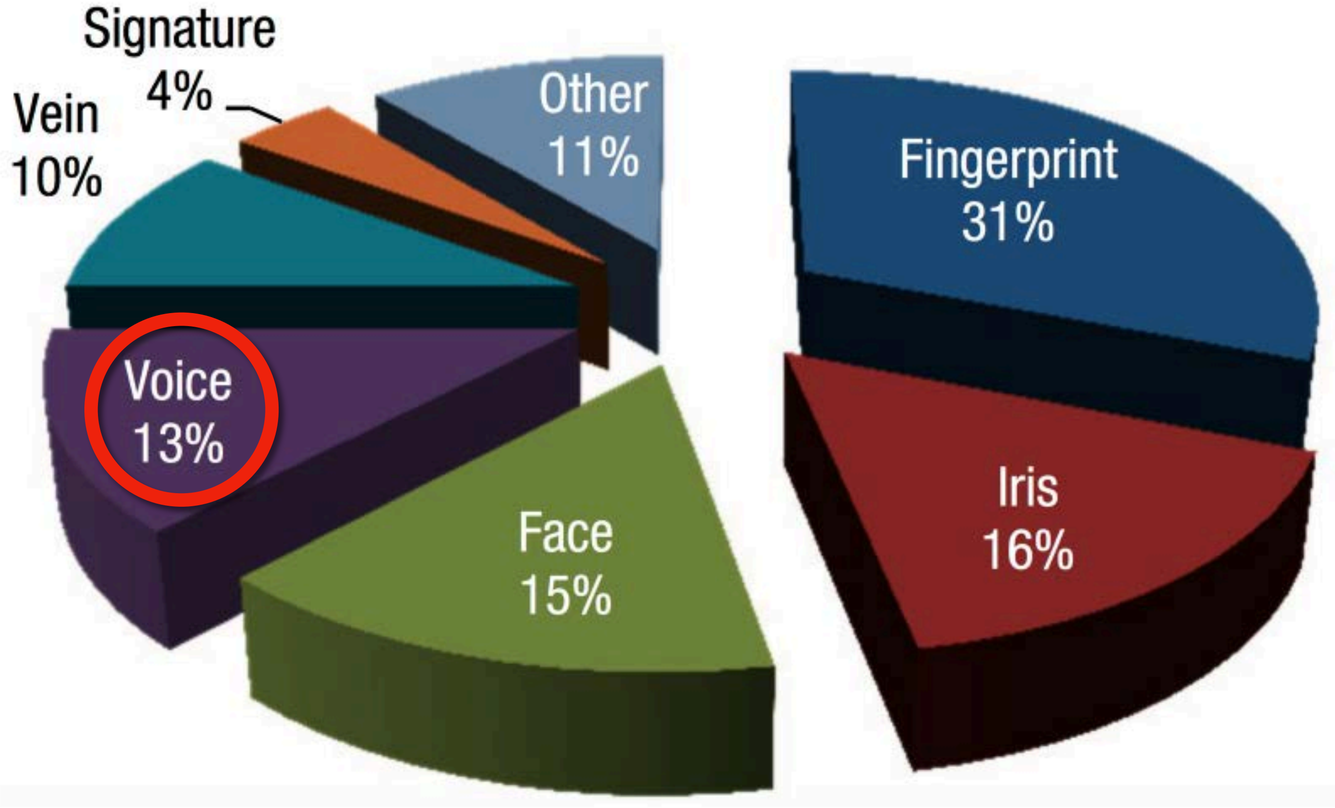


Source: Mani and Nadeski, *Processing solutions for biometric systems,* Texas Instruments, 2015

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Alternative Traits

Market



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

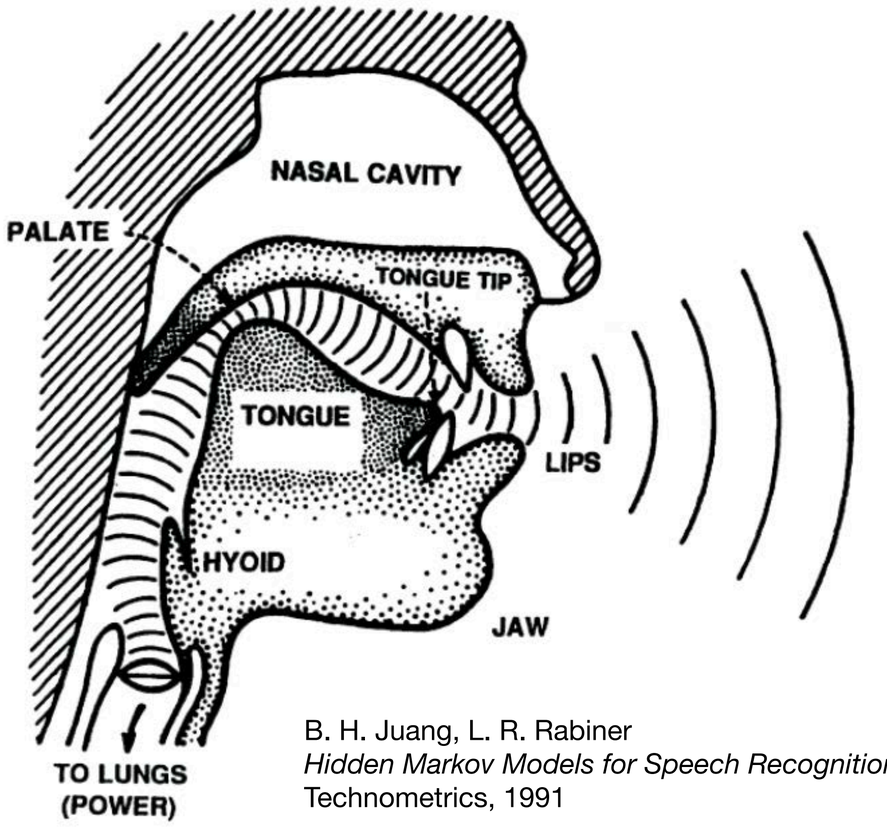
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Voice Recognition

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.



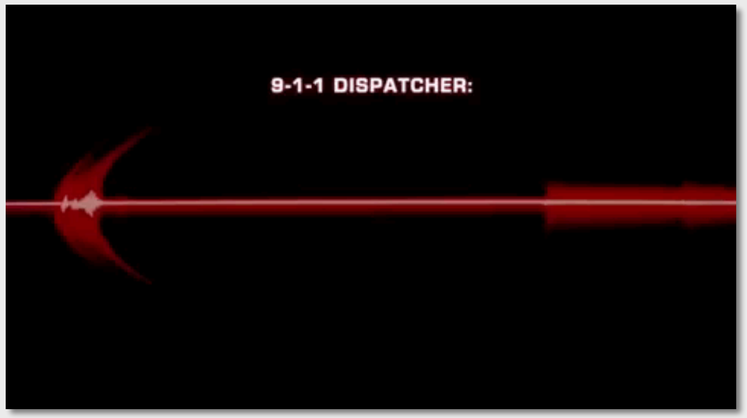
B. H. Juang, L. R. Rabiner
Hidden Markov Models for Speech Recognition
Technometrics, 1991

LOYOLA
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Voice Recognition

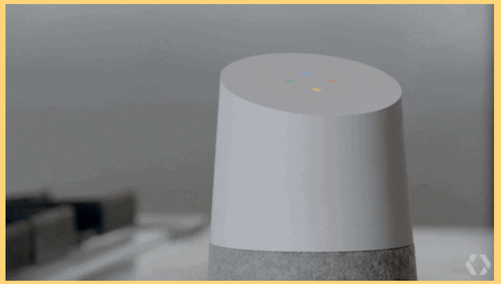
Acquisition

Off-line



On-line

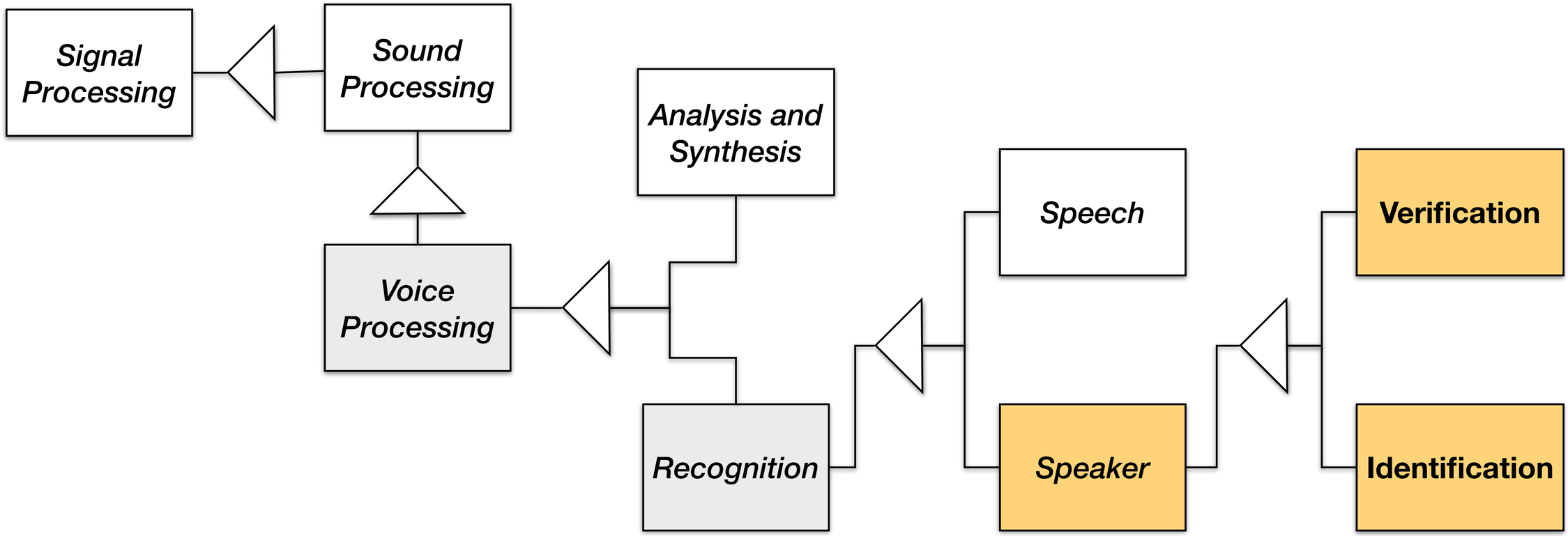




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Voice Recognition

Field Development



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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

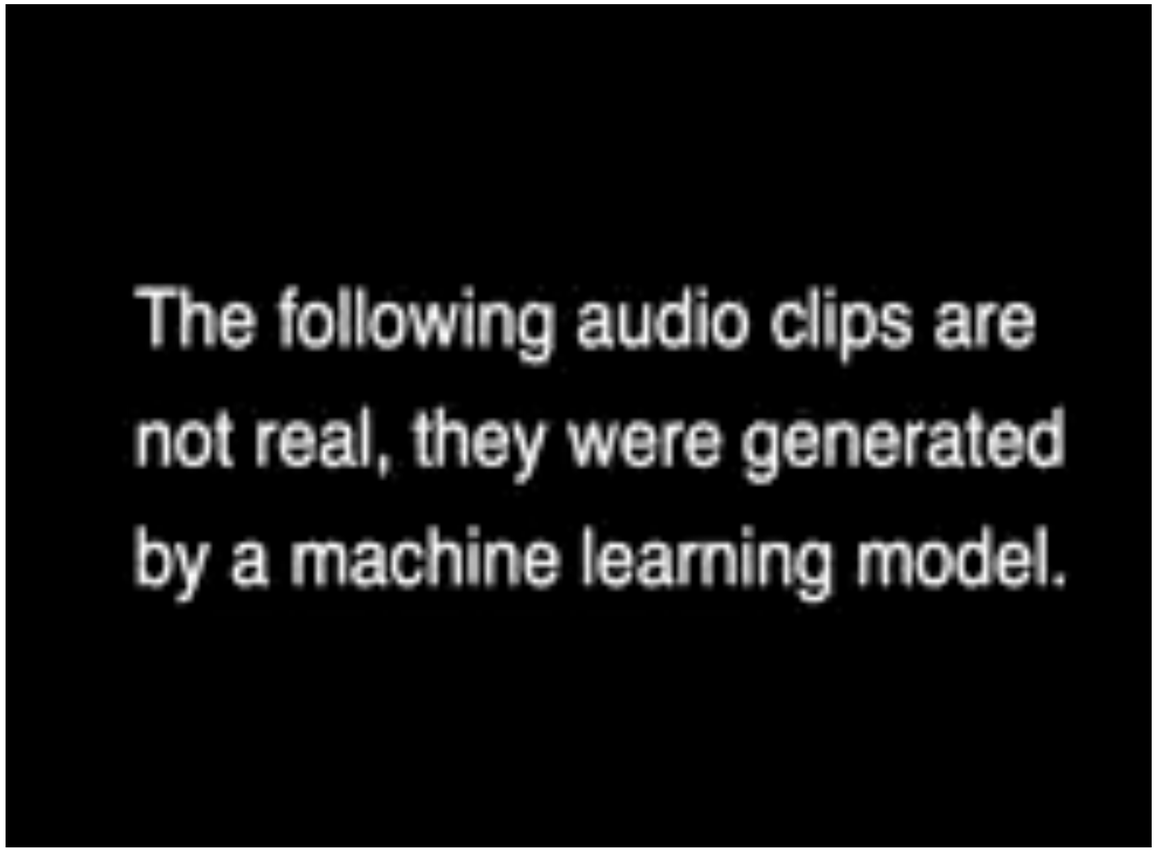


increases

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Voice Recognition

A New Era of Presentation Attack

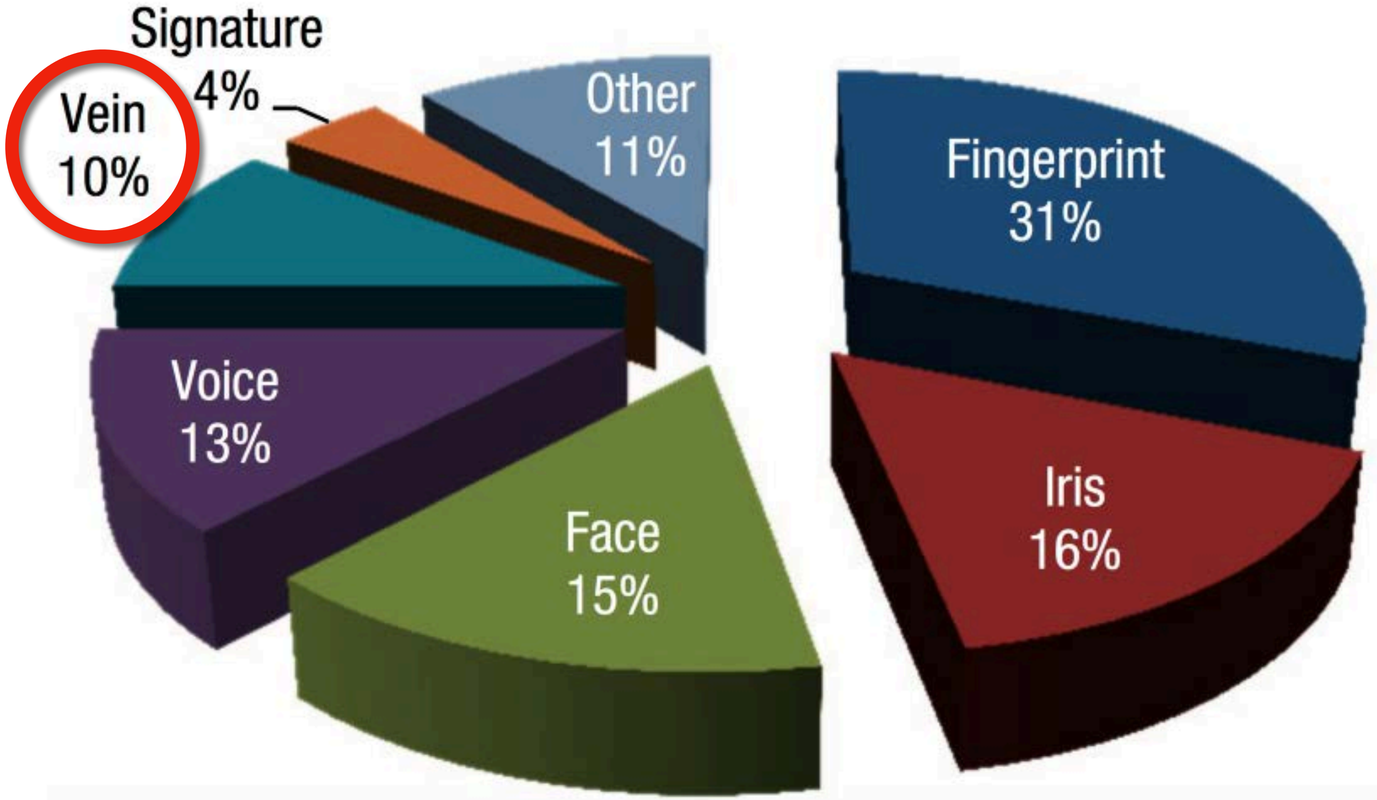


https://www.youtube.com/watch?v=DWK_iYBl8cA

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Alternative Traits

Market



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

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Vein Recognition

Human Circulatory System

Veins are *epigenetic*.

Commonest modalities:
palm and finger veins.



Dr. Adam Czajka



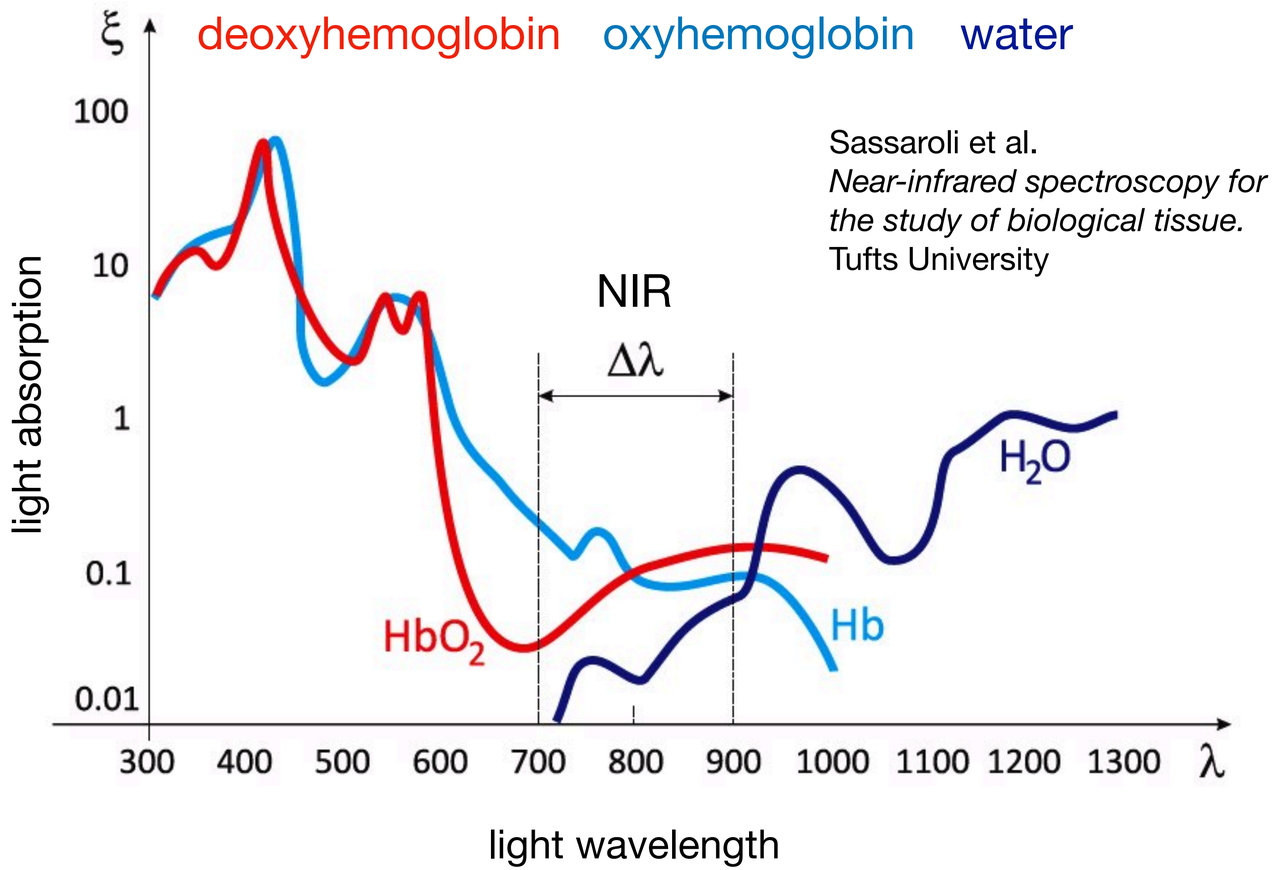
Hitachi
Finger Vein Authentication
White Paper, 2004

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Vein Recognition

Acquisition

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

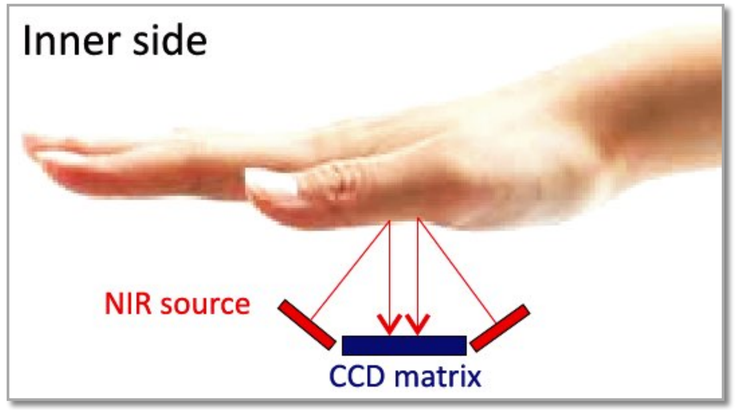


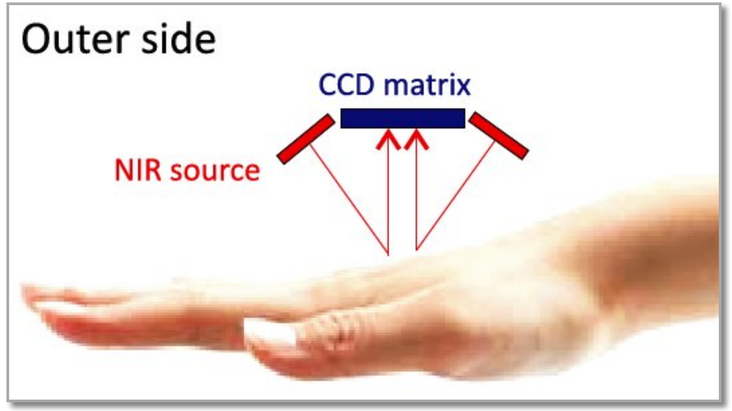
Sassaroli et al.
Near-infrared spectroscopy for the study of biological tissue.
Tufts University

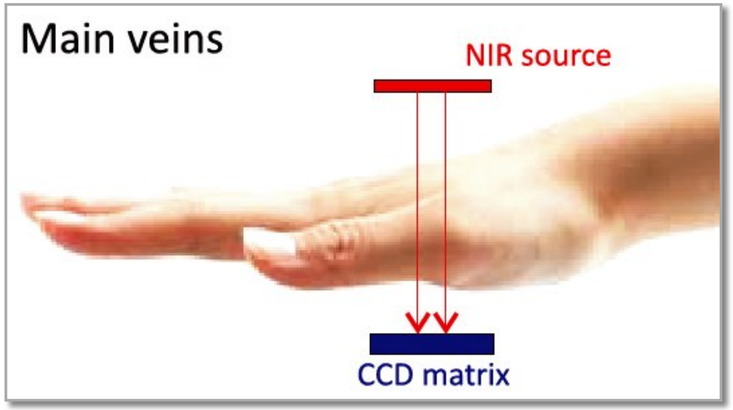
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Vein Recognition

Palm Vein Acquisition







Dr. Adam Czajka

CCD: Charge-Coupled Device camera

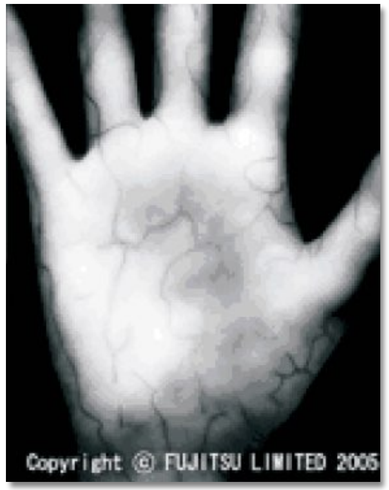
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Vein Recognition

Palm Vein Acquisition

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





Fujitsu PalmSecure reader



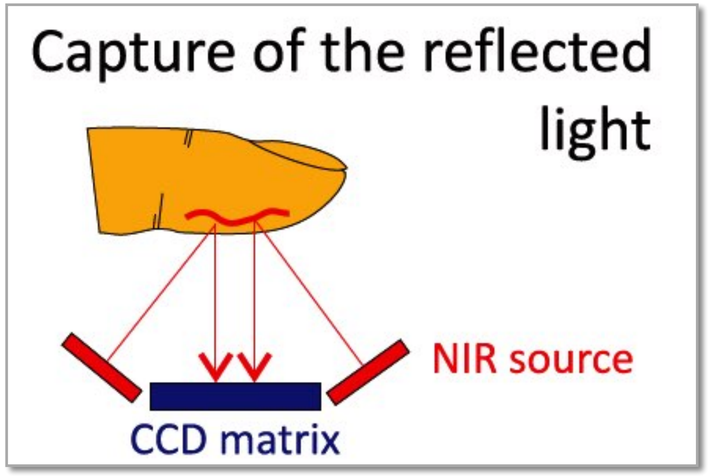


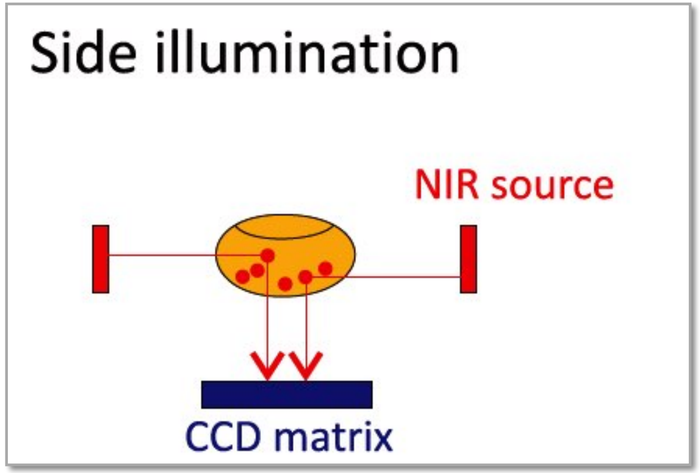
Techsphere VP II reader

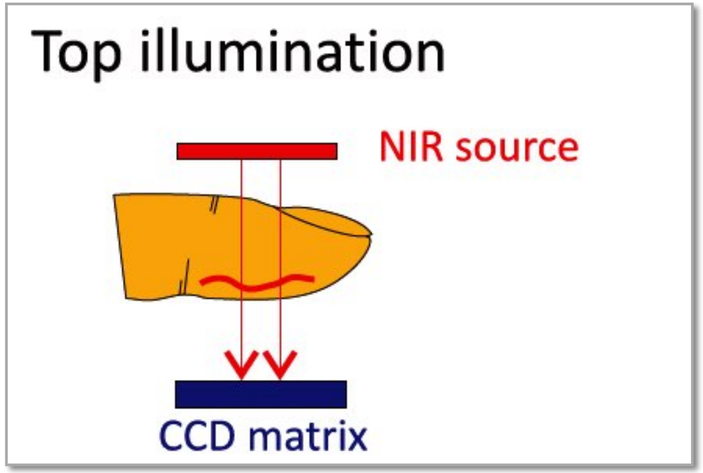
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Vein Recognition

Finger Vein Acquisition







Dr. Adam Czajka

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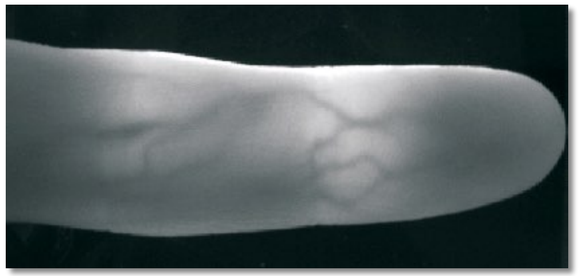
Vein Recognition

Finger Vein Acquisition



Hitachi H1 reader
(with top illumination)

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

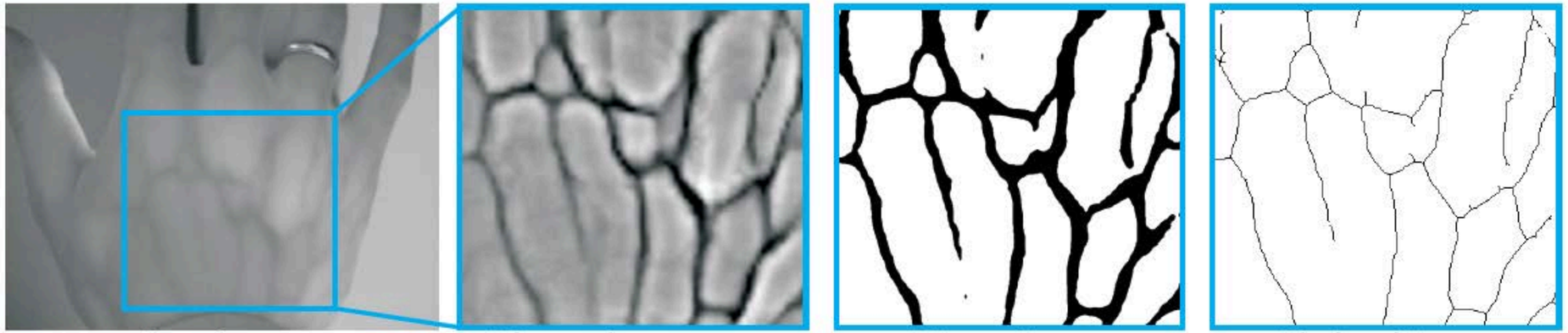


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Vein Recognition

Vein Description Strategies

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Vein Recognition

Vein Description Strategies



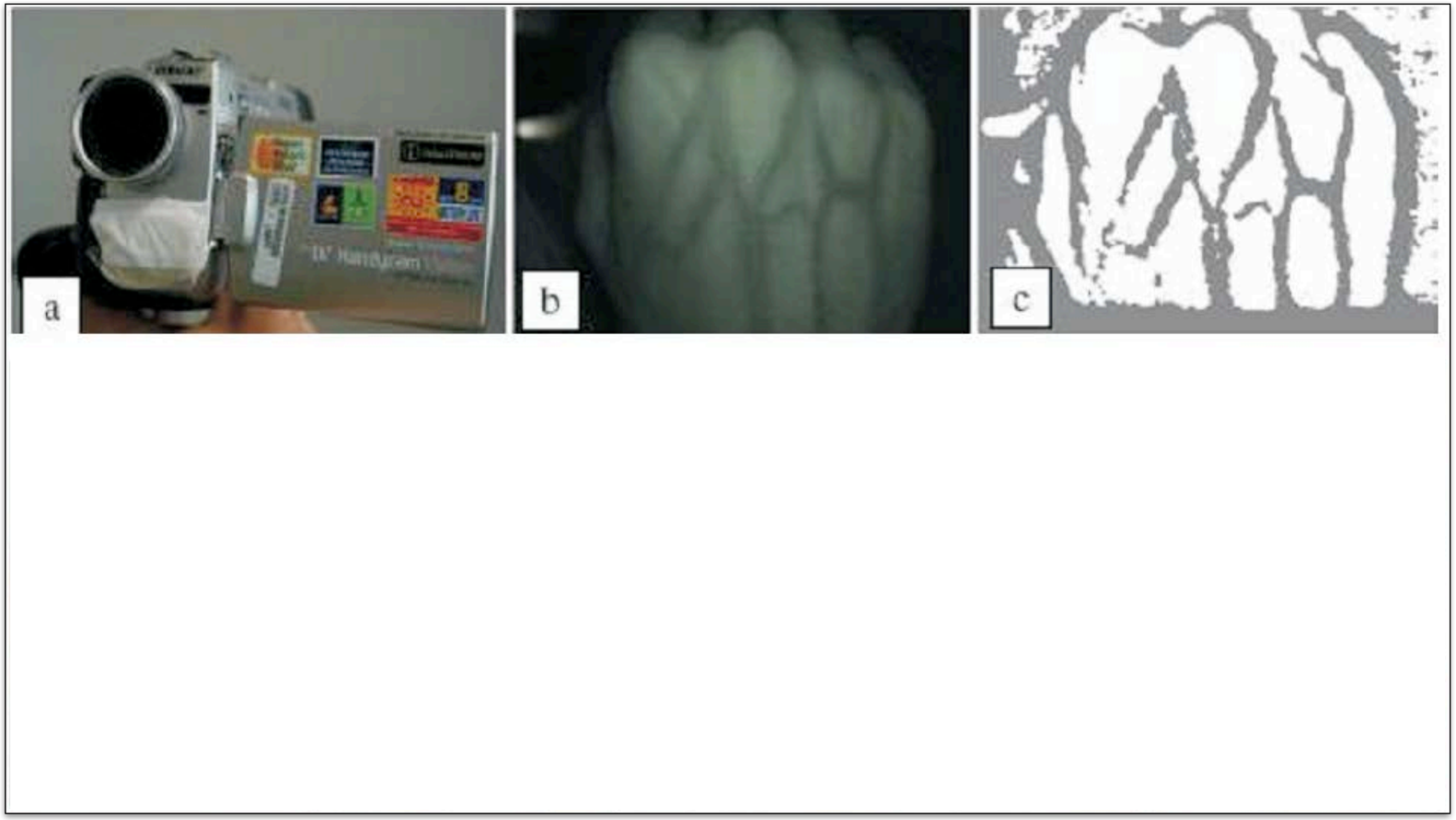


Miura et al.
Extraction of Ginger-Vein Patterns Using Maximum Curvature Points in Image Profiles
IAPR 2005

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Vein Recognition

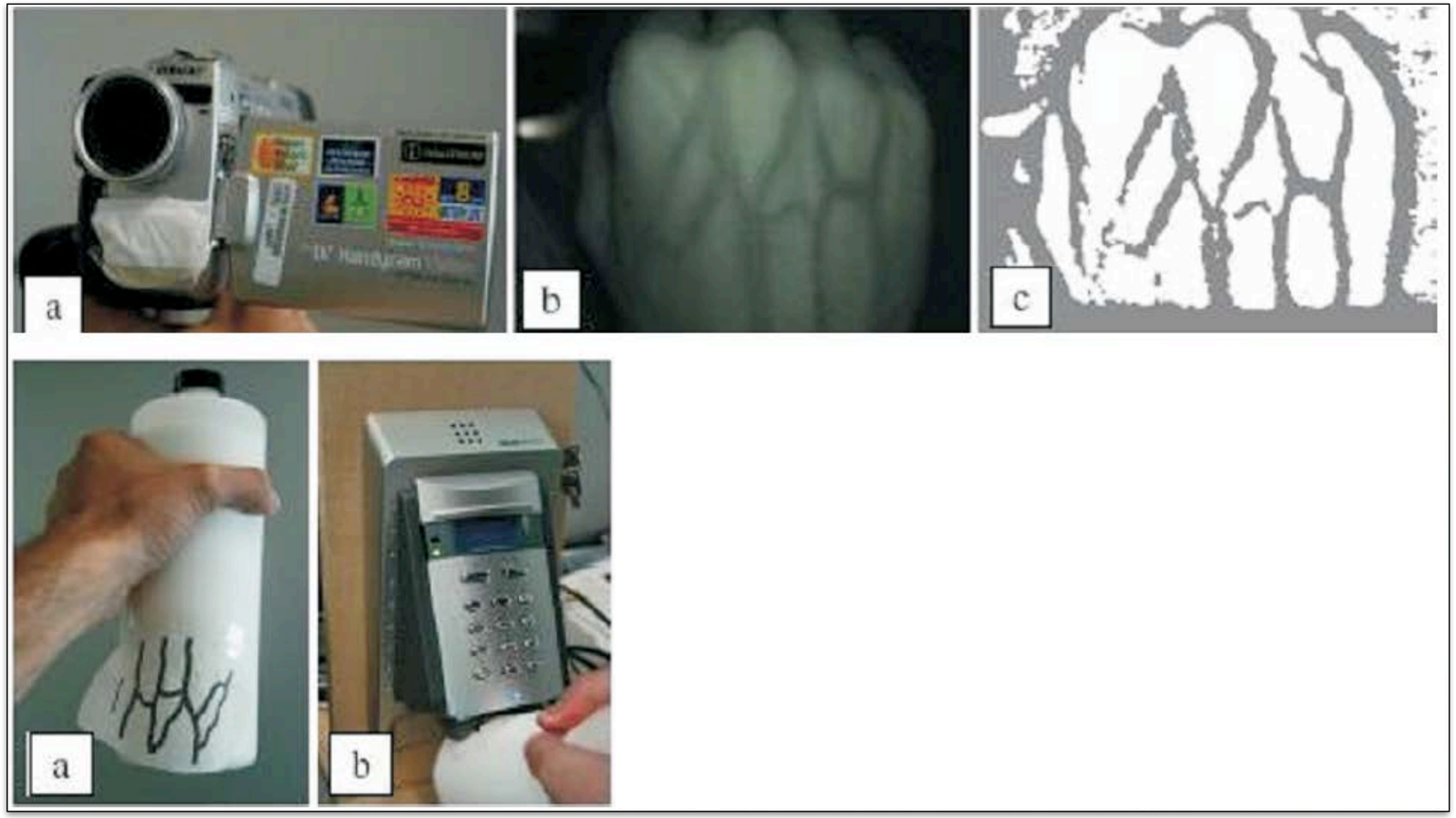
Presentation Attack



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Vein Recognition

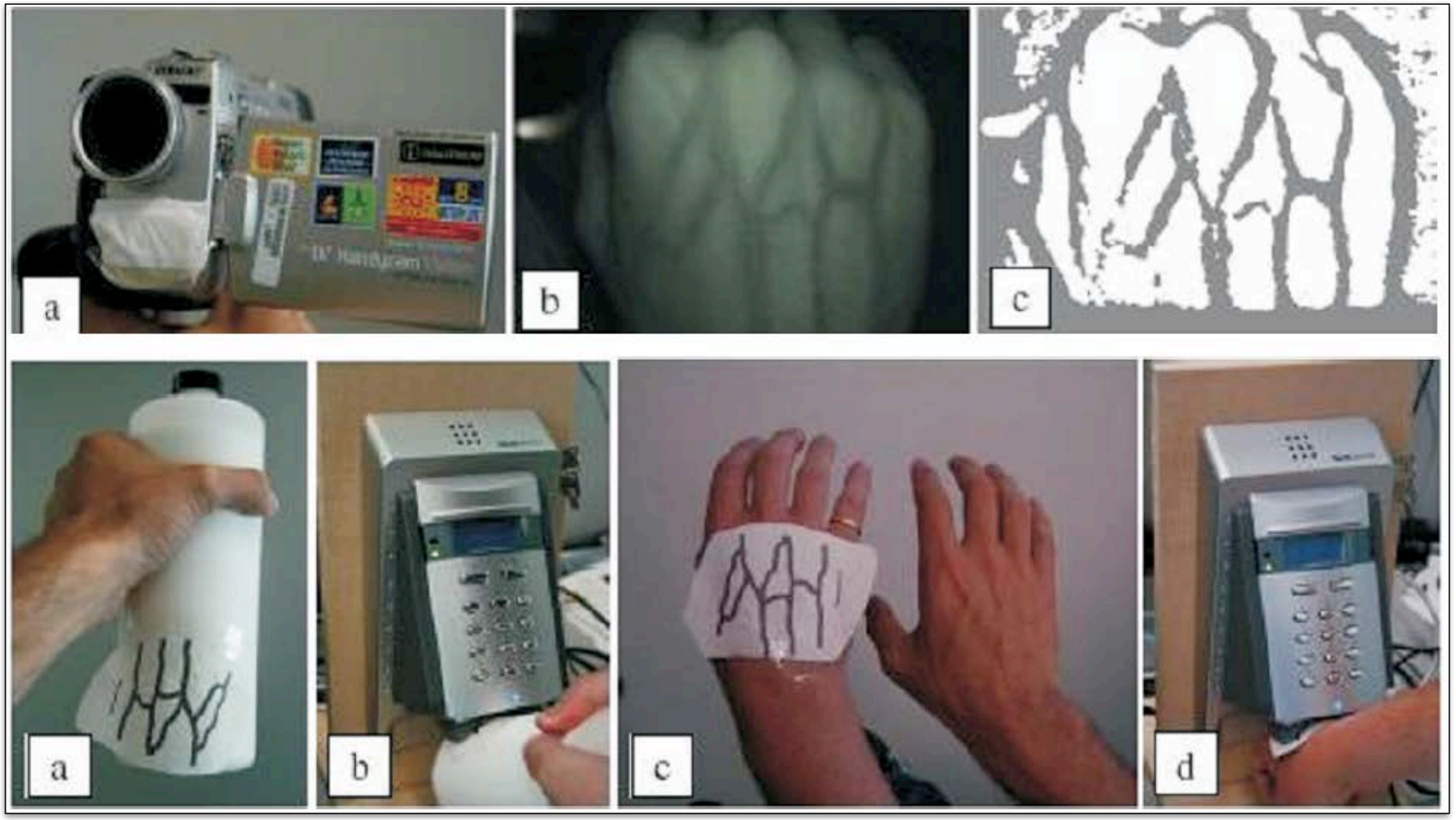
Presentation Attack



LOYOLA UNIVERSITY CHICAGO

Vein Recognition

Presentation Attack



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

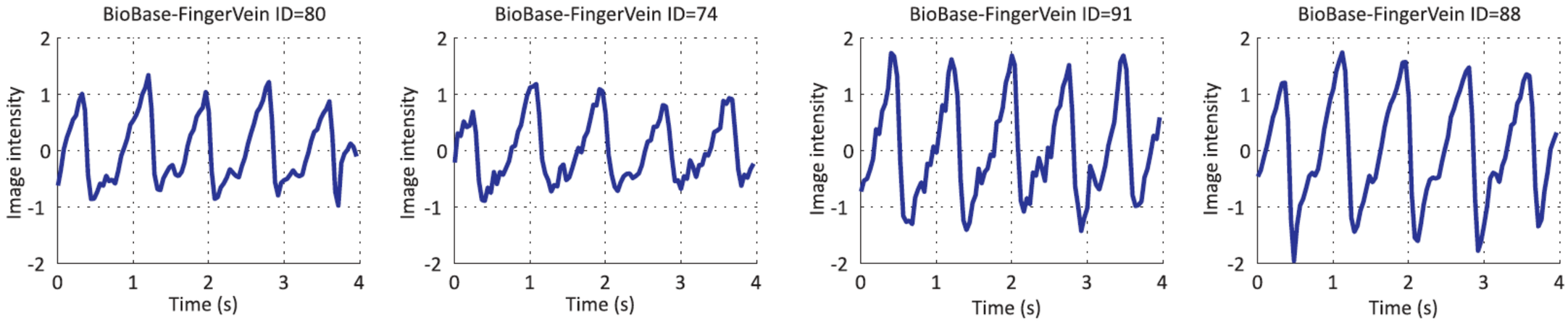
LOYOLA UNIVERSITY CHICAGO

Vein Recognition

Presentation Attack Detection

Blood Pulse Detection

Dr. Adam Czajka

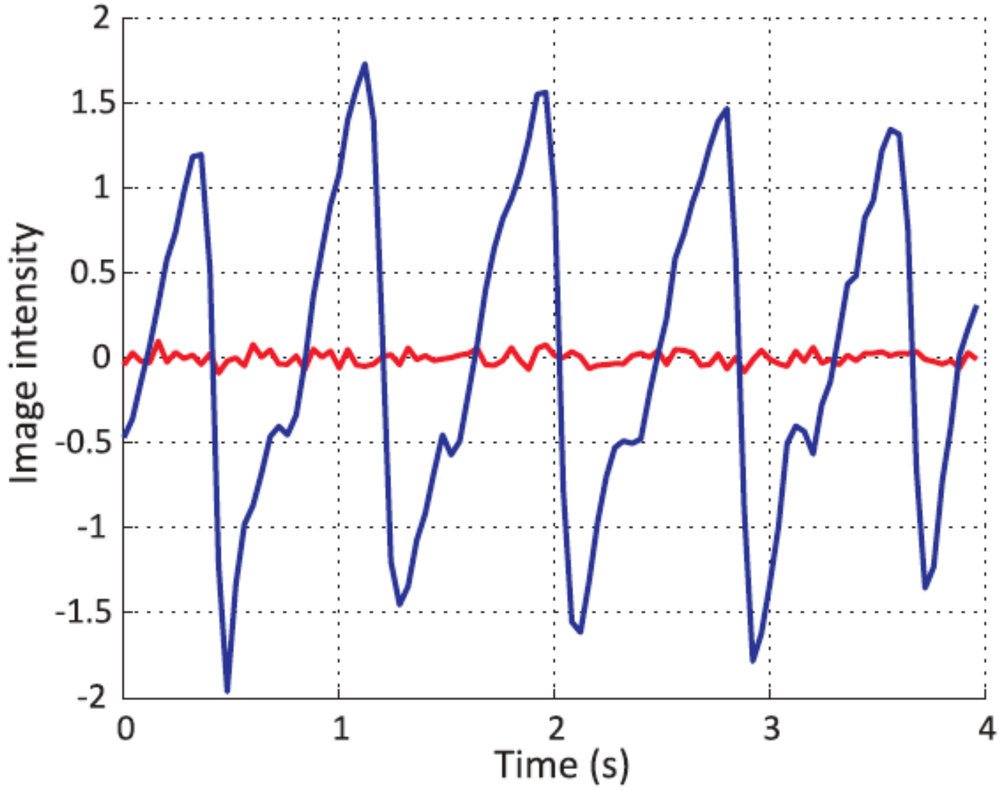


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Vein Recognition

Presentation Attack Detection

Blood Pulse Detection



Dr. Adam Czajka

Forgery

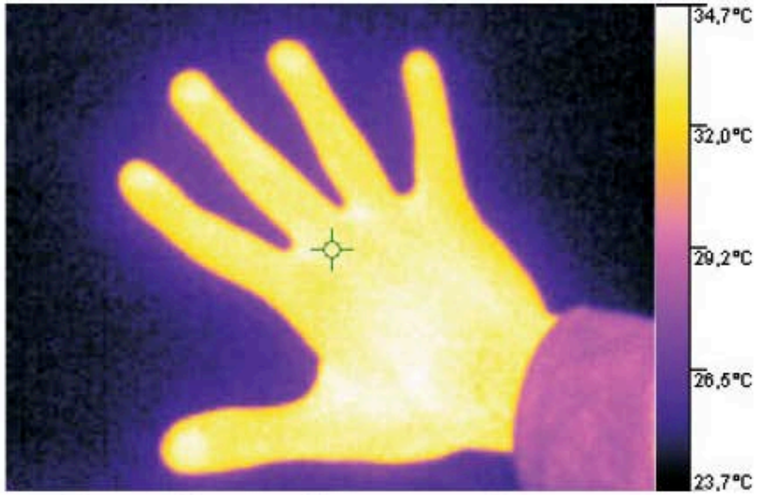
LOYOLA UNIVERSITY CHICAGO

Vein Recognition

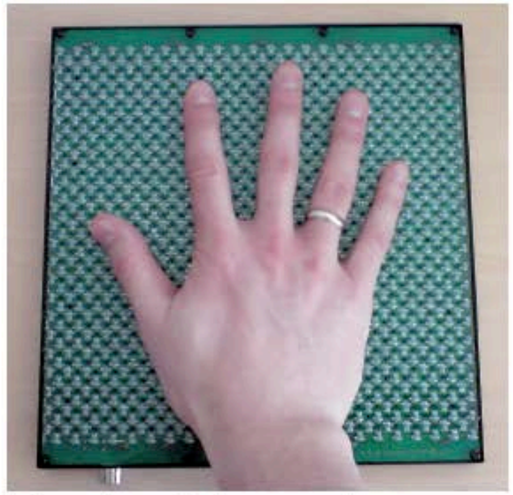
Presentation Attack Detection

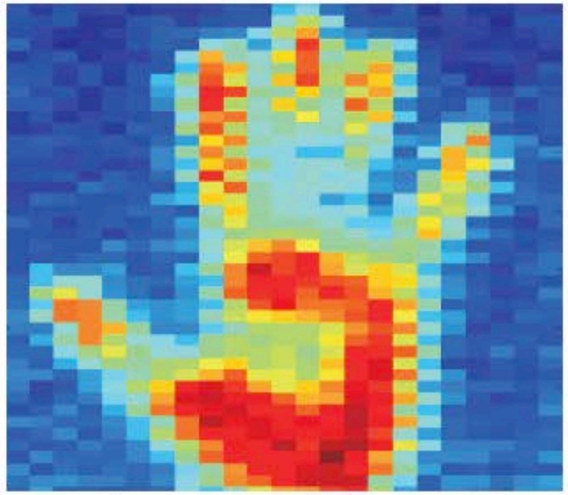
Temperature Measurement

Dr. Adam Czajka



Raw thermal camera image

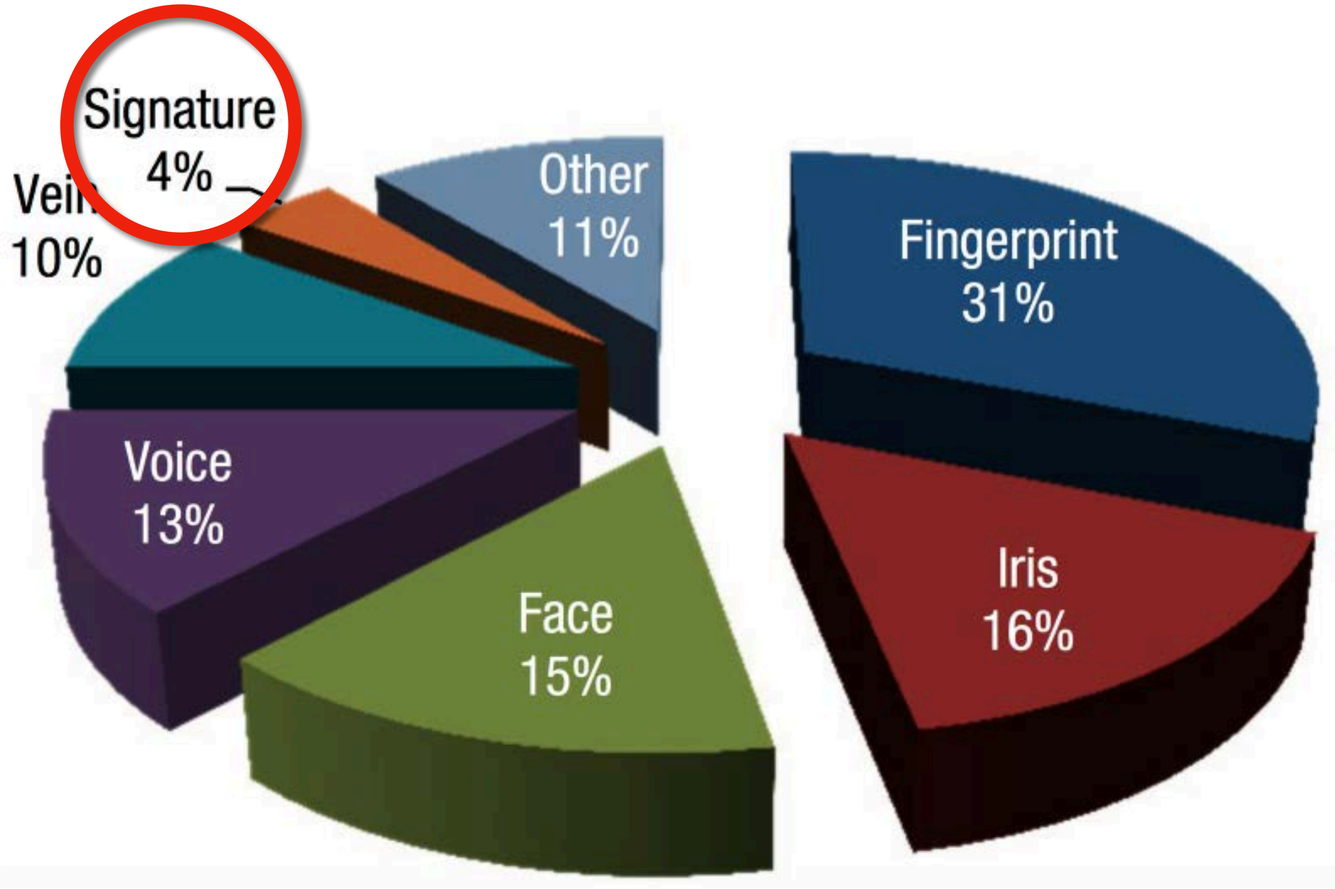

Matrix of thermal sensors


Raw matrix image

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Alternative Traits

Market



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

LOYOLA UNIVERSITY CHICAGO

Signature Recognition

Behavioral Trait





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Signature Recognition

Acquisition

Off-line





On-line



https://www.youtube.com/watch?v=Y1449tOo7Xw

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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.



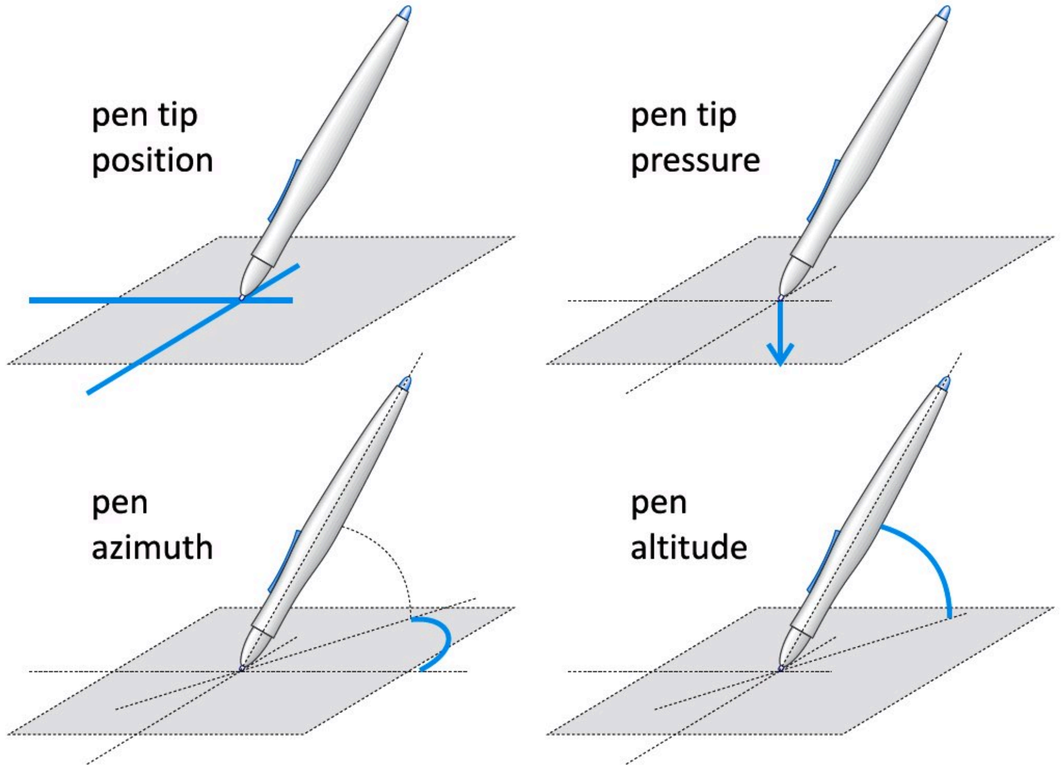
https://www.youtube.com/watch?v=NPf2otAxB8U

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Signature Recognition

On-line Acquisition

Various components are captured from the signing behavior.



Dr. Adam Czajka

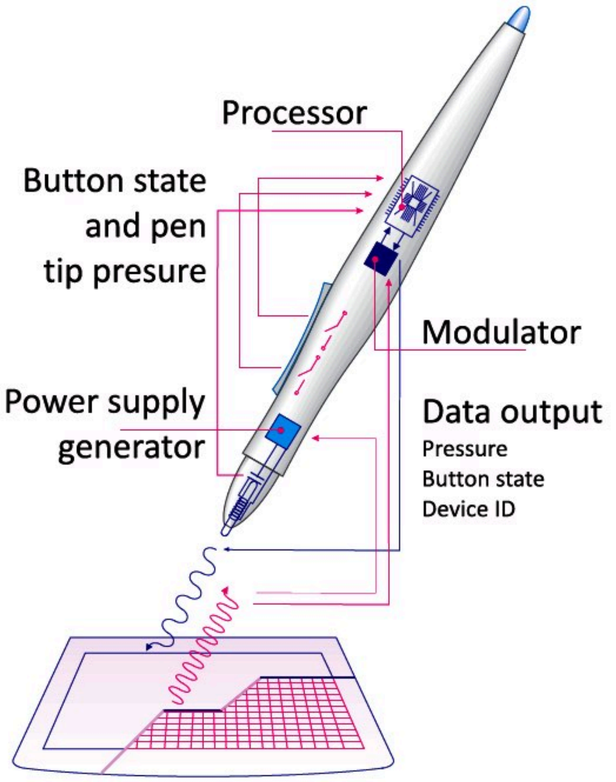
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Signature Recognition

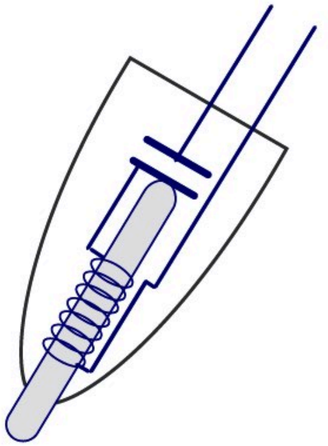
On-line Acquisition

Various components are captured from the signing behavior.

Special sensors
(such as digitizing tablets).



Dr. Adam Czajka



Inductor-capacitor circuit (LC circuit)

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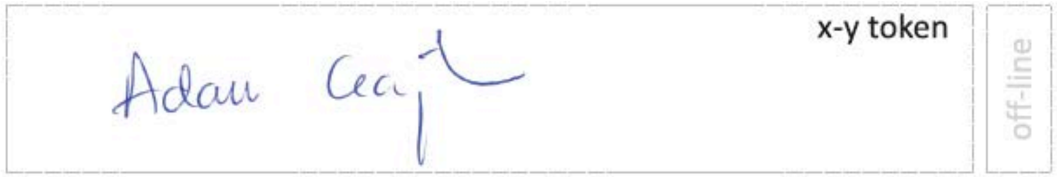
Aided by computer
(*acquisition*, *enhancement*, *feature extraction*, *matching*, *decision*).

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Signature Recognition

On-line Acquisition

Signature Tokens



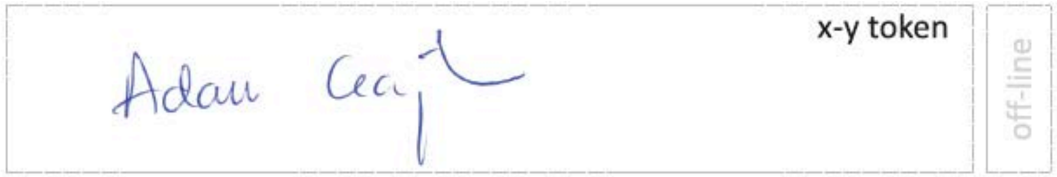
Dr. Adam Czajka

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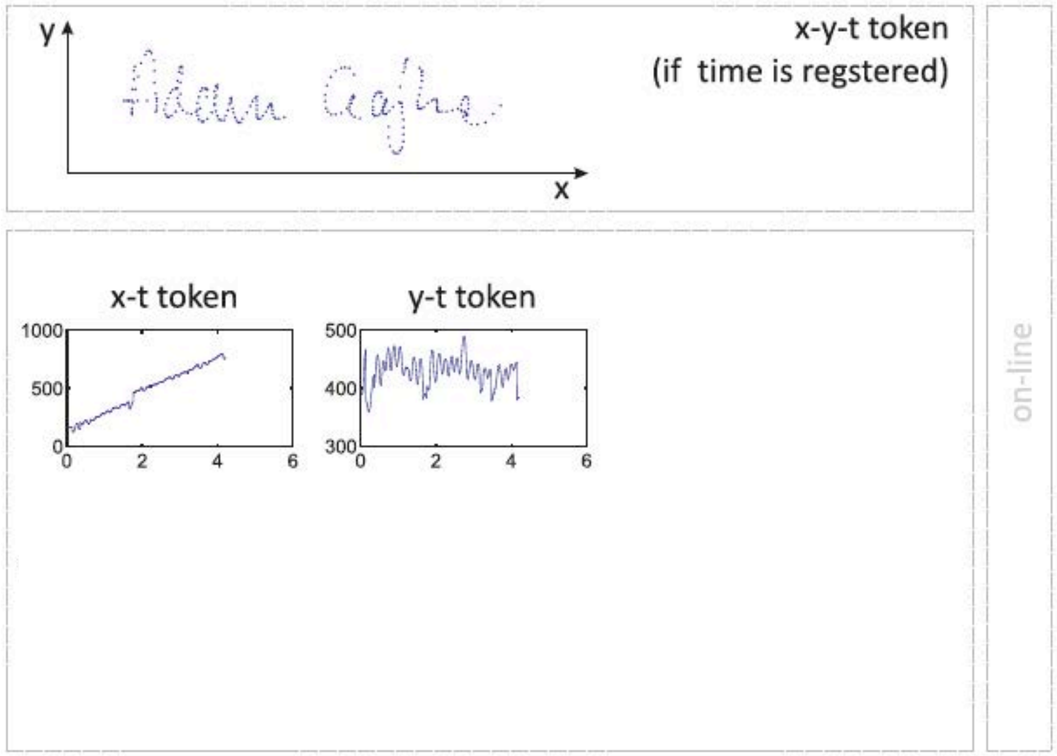
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka

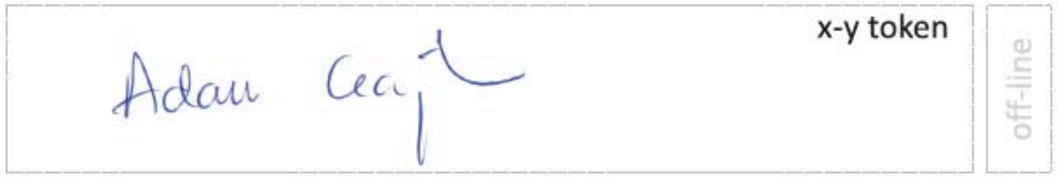


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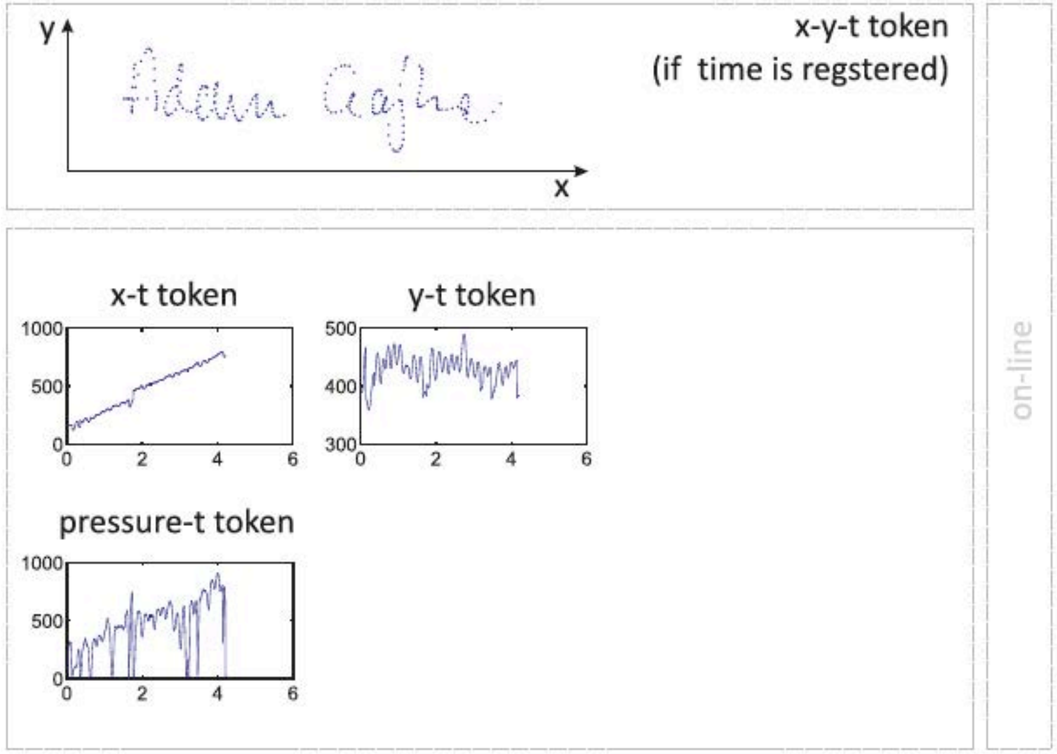
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka

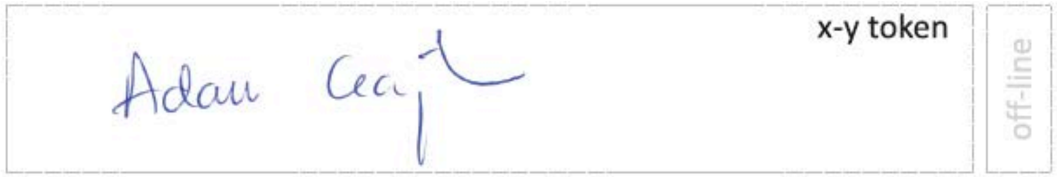


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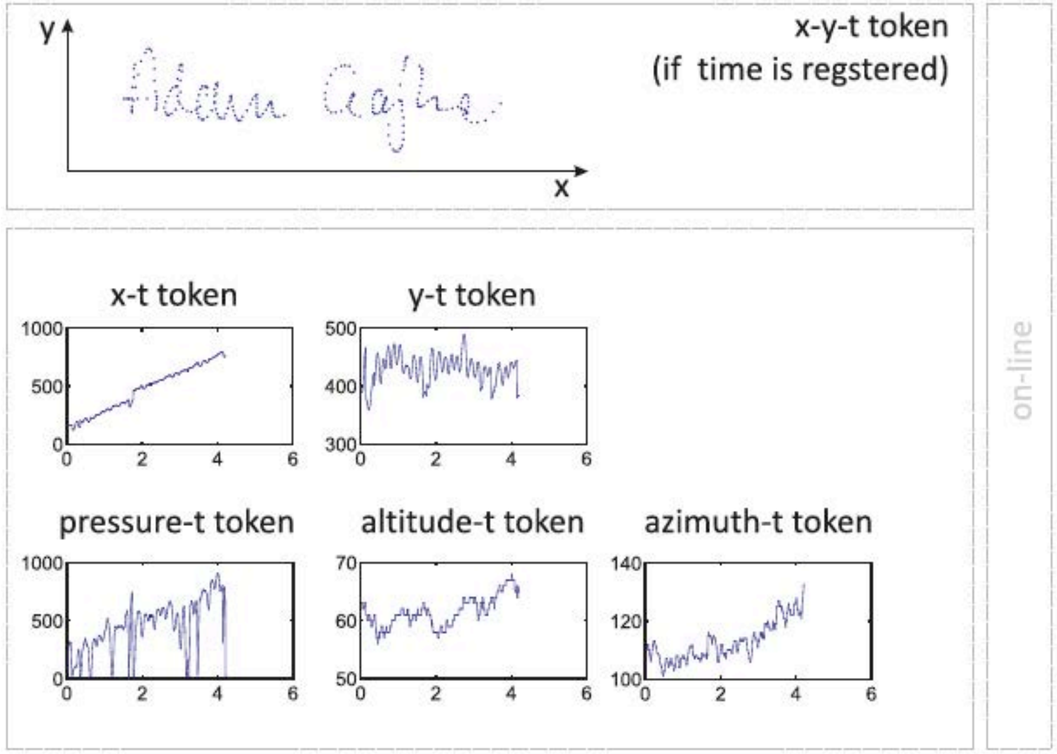
Signature Recognition

On-line Acquisition

Signature Tokens



Dr. Adam Czajka

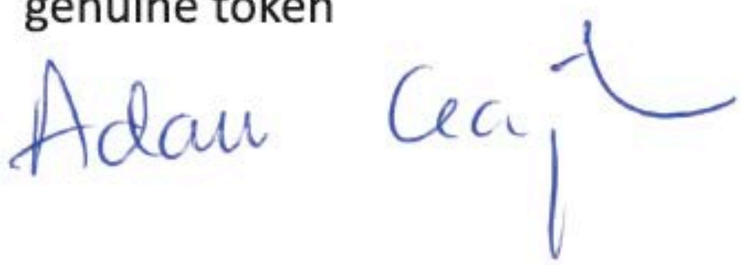


LOYOLA UNIVERSITY CHICAGO

Signature Recognition

Presentation Attack

genuine token

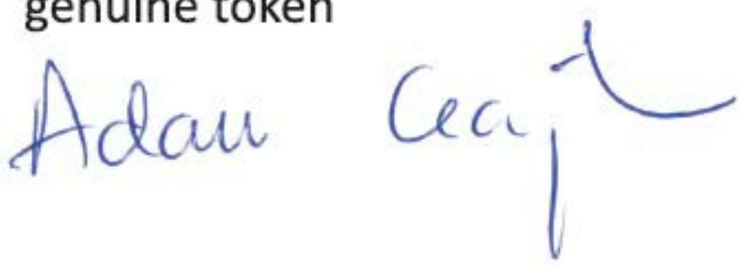


LOYOLA UNIVERSITY CHICAGO

Signature Recognition

Presentation Attack

genuine token



Whatever, dude.

random forgery

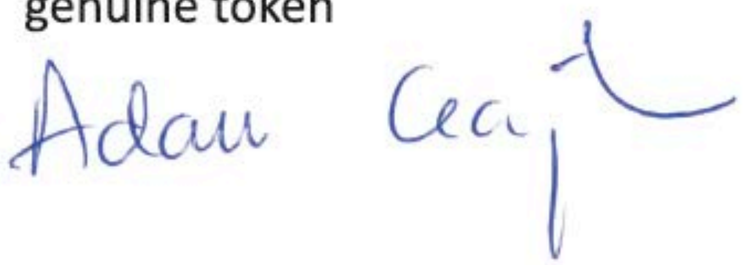


LOYOLA UNIVERSITY CHICAGO

Signature Recognition

Presentation Attack

genuine token



simple forgery



I know your name.

Whatever, dude.

random forgery

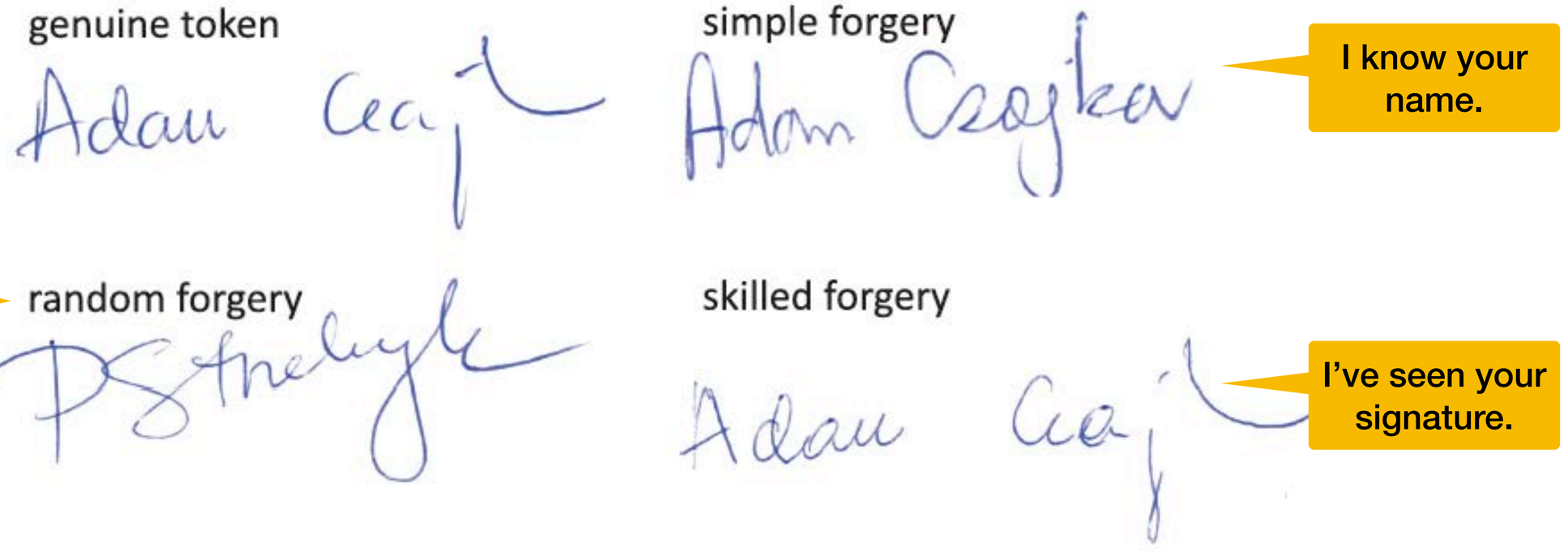


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Signature Recognition

Presentation Attack

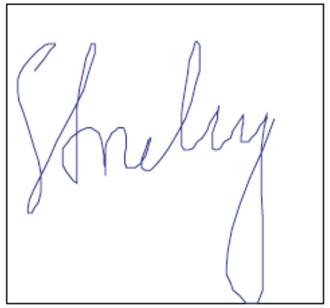
Dr. Adam Czajka

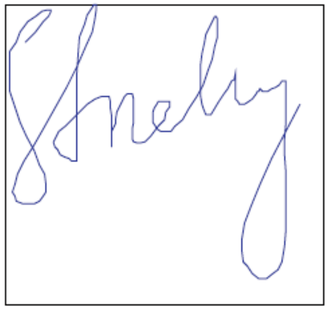


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Signature Recognition

Presentation Attack Detection

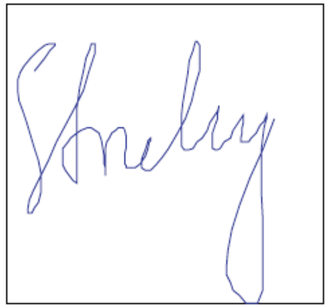


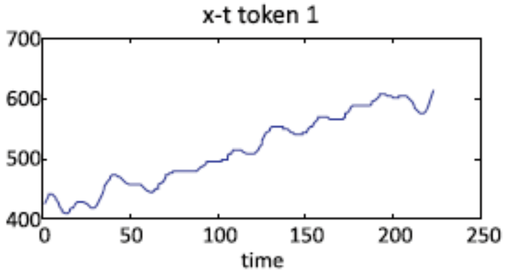


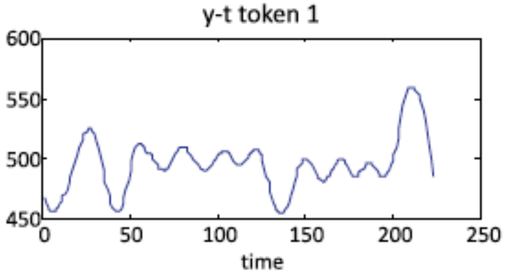
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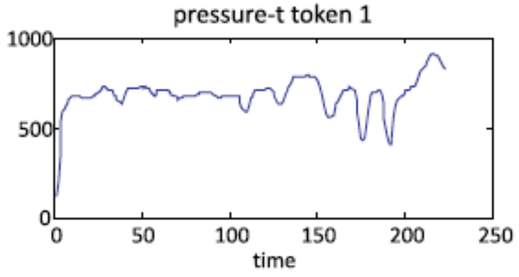
Signature Recognition

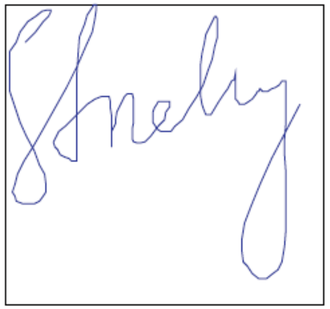
Presentation Attack Detection









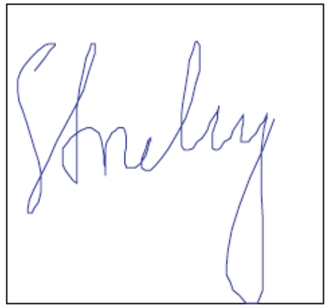


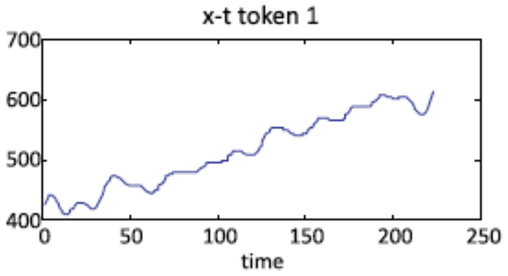
LOYOLA UNIVERSITY CHICAGO

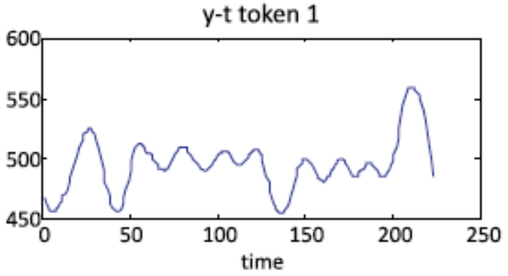
Signature Recognition

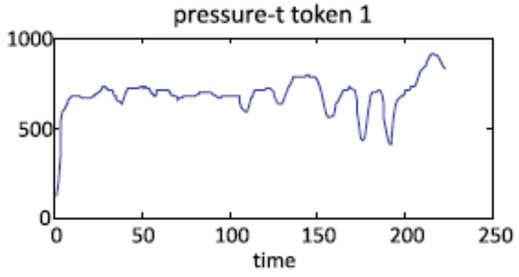
Presentation Attack Detection

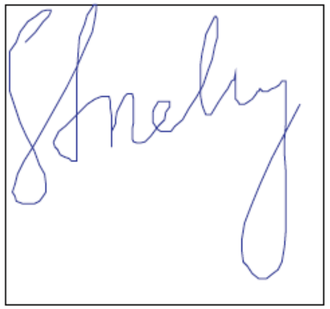
Dr. Adam Czajka

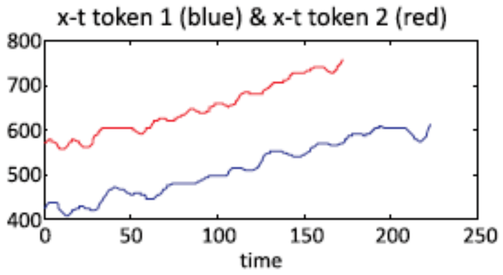


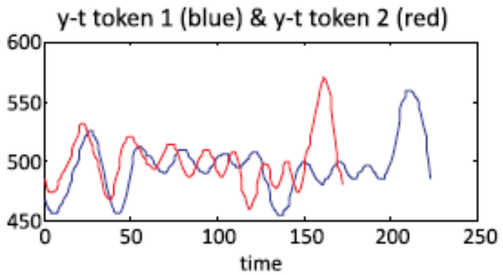


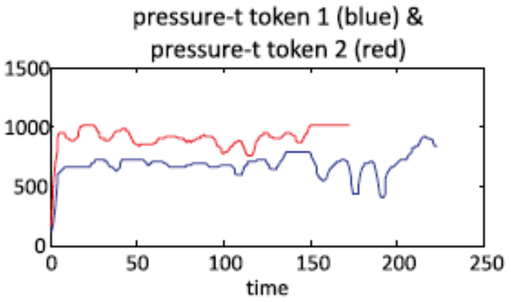








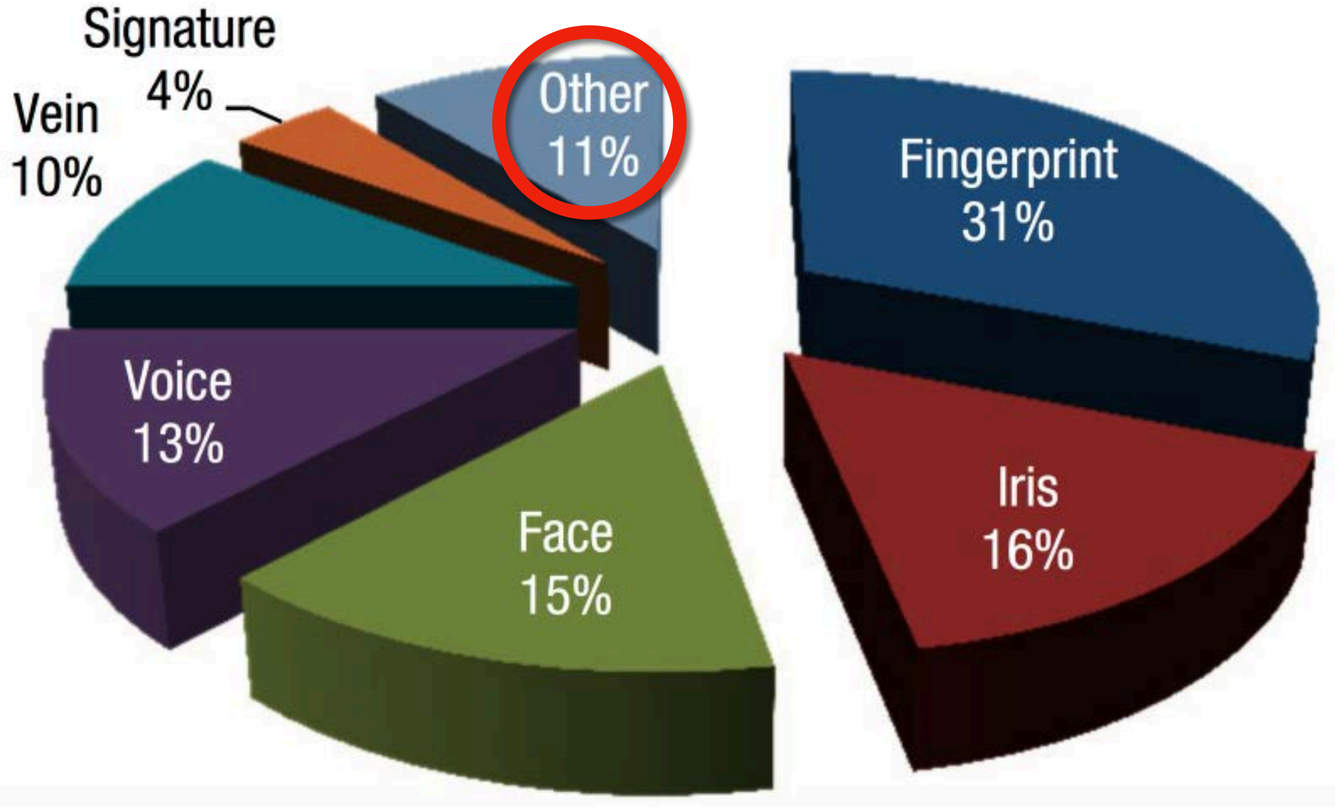




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Alternative Traits

Market



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

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Palmprint Recognition

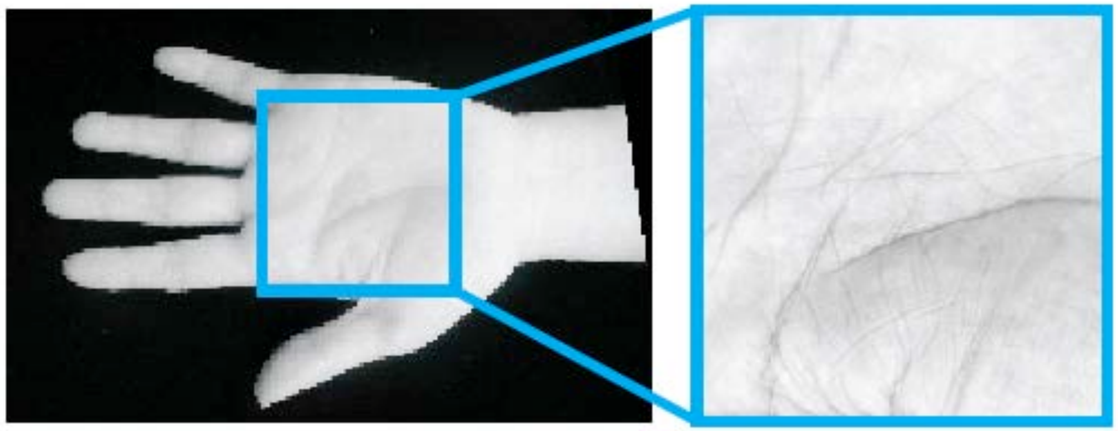
Level-1 Features

Main Lines

Yes: Direction, bifurcations, endings, and crossings.

No: “line of life”, “line of fate”, you name it.

Dr. Adam Czajka



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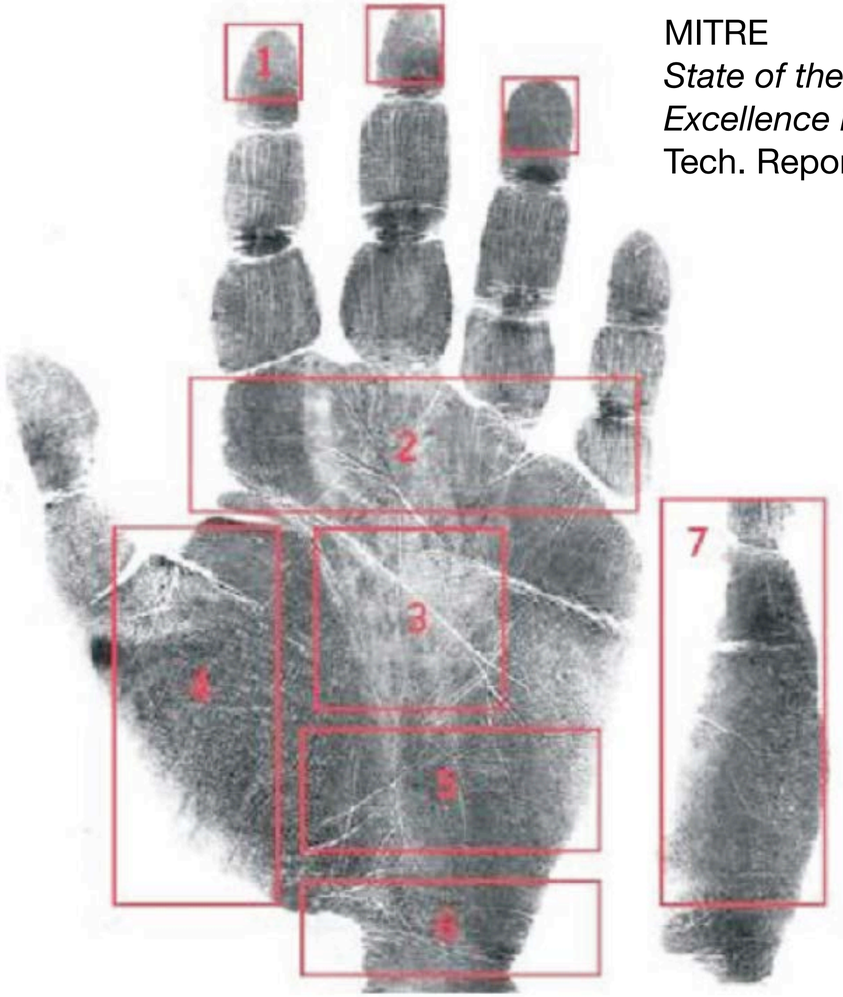
Palmprint Recognition

Level-2 Features

Minutiae

Ridge endings and bifurcations (position and angle).

Focus on the inner and side portion of the hand.

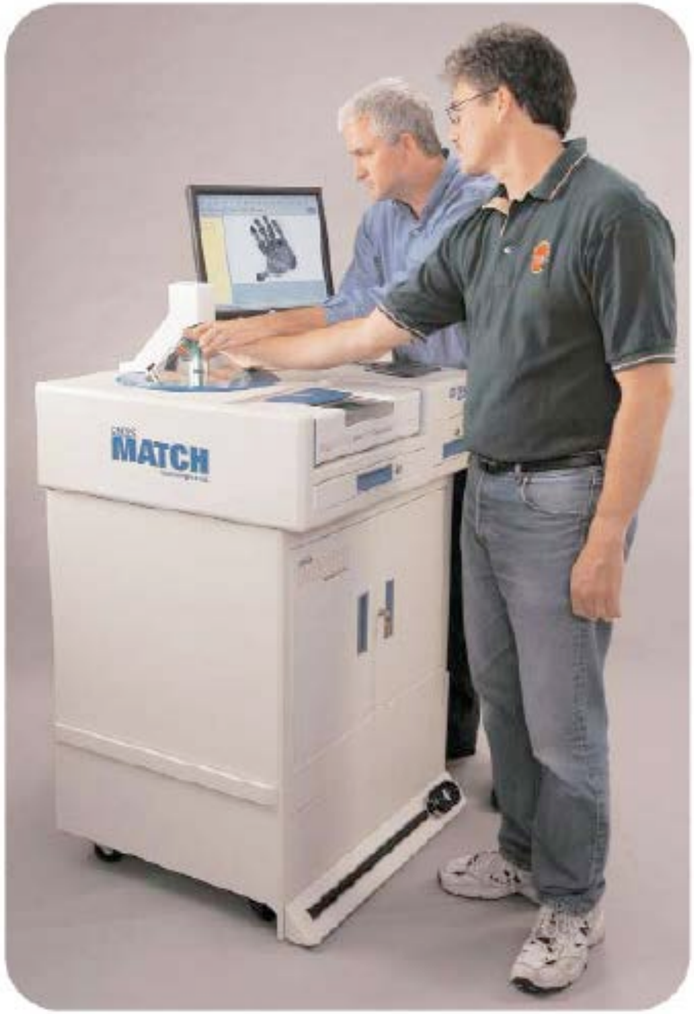


MITRE
State of the Art Biometrics Excellence Roadmap
Tech. Report, 2008

Palmprint Recognition

On-line Acquisition





CrossMatch ID 2500
Dr. Adam Czajka

Other Traits



DNA



Gate



Ears

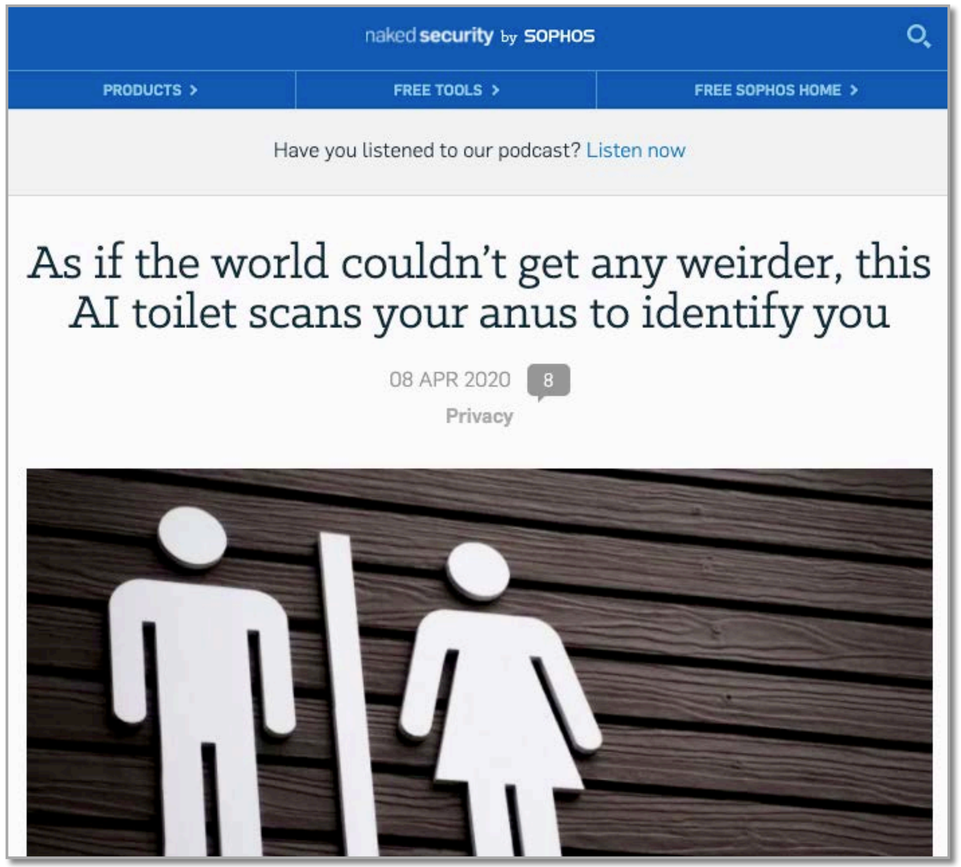


Tongue Print

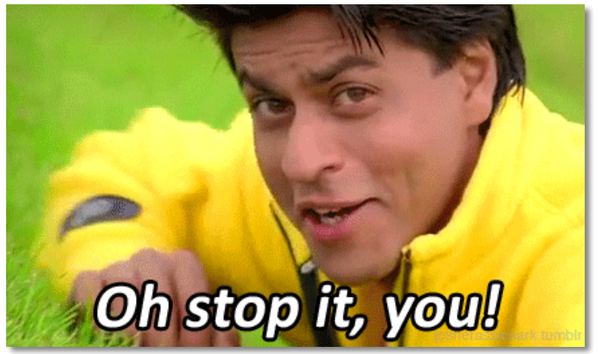
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Other Traits

Ahem…



https://www.vice.com/en/article/stanford-smart-toilet-uses-butthole-for-identification/



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Soft Biometrics

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

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Soft Biometrics

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

Benefits
Recognition accuracy improvement
Recognition runtime reduction

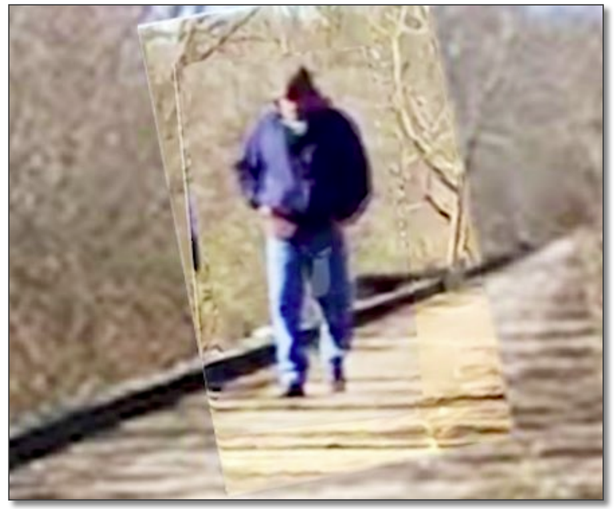
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Soft Biometrics

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://tinyurl.com/3e8vm4vf

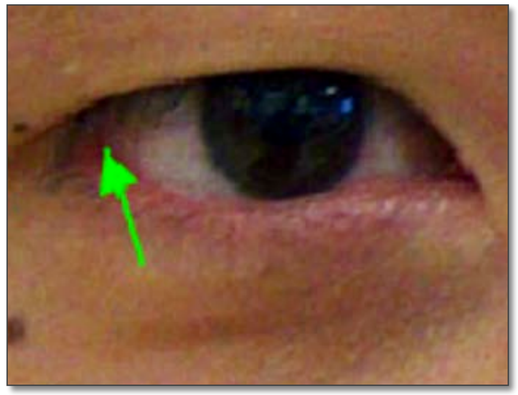
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Soft Biometrics

What can you guess?
Periocular region and eye color

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






Gender?
Ethnicity?
Age?

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Soft Biometrics

Other traits

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



moles, scars, marks



birthmarks



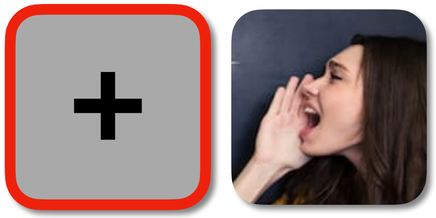
tattoos

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What's Next?

Fusion (a.k.a. Multibiometrics)

Fill out your
Today-I-missed Statement
Please visit sakai.luc.edu/x/Dv5DsU.



Alternative Traits and
Fusion
Concepts



Invited Talks (2)
State of the art
Future work

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