Dissertation Defense
Physical Object Identification and Authentication Applications

Welcome

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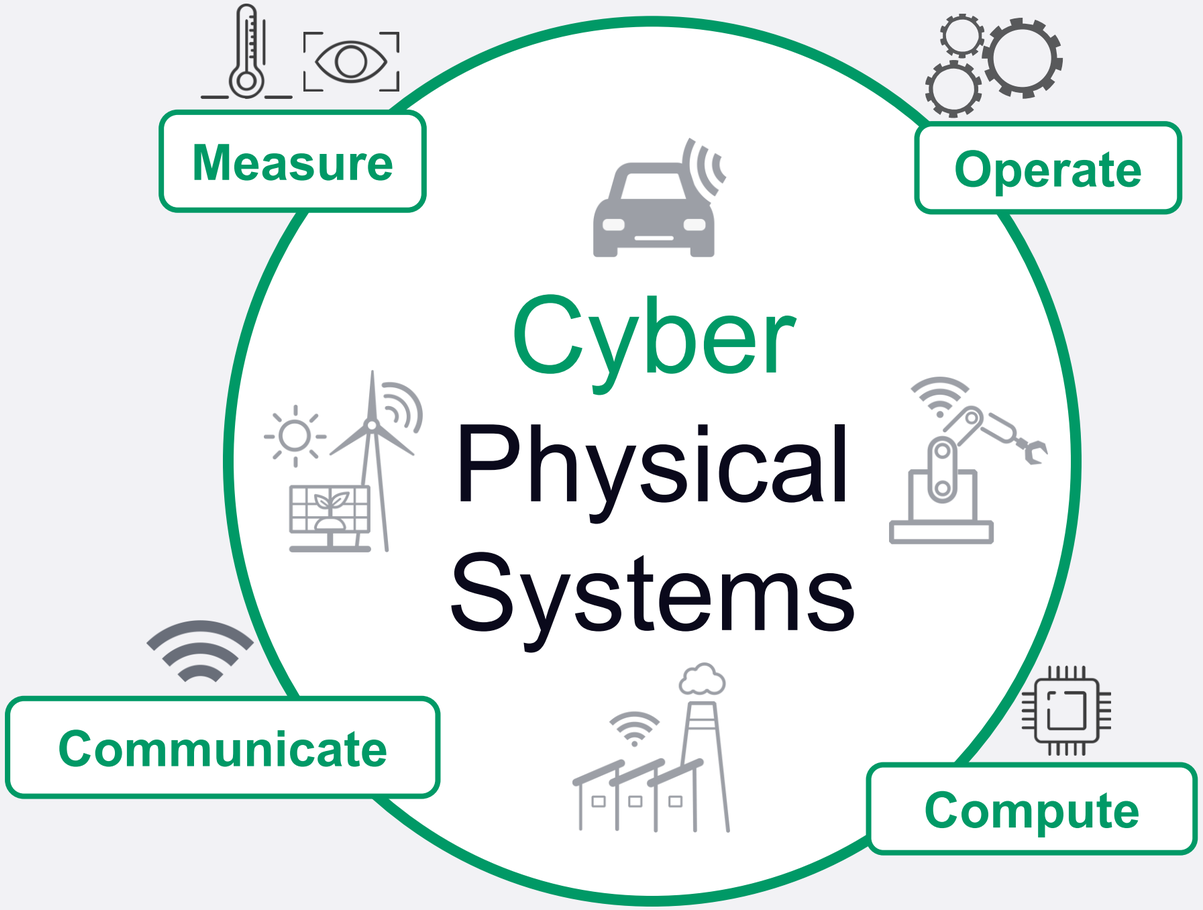
Physical Object Identification and Authentication Applications
Content

TreeTrace AquaMonit

Introduction [1/3]
Cyber Physical Systems (CPS)



Introduction [2/3]
Physical marking-free Object Identification

Human Biometrics

Biometrics is a technology used to identify, analyze, and measure an individual's physical and behavioral characteristics.

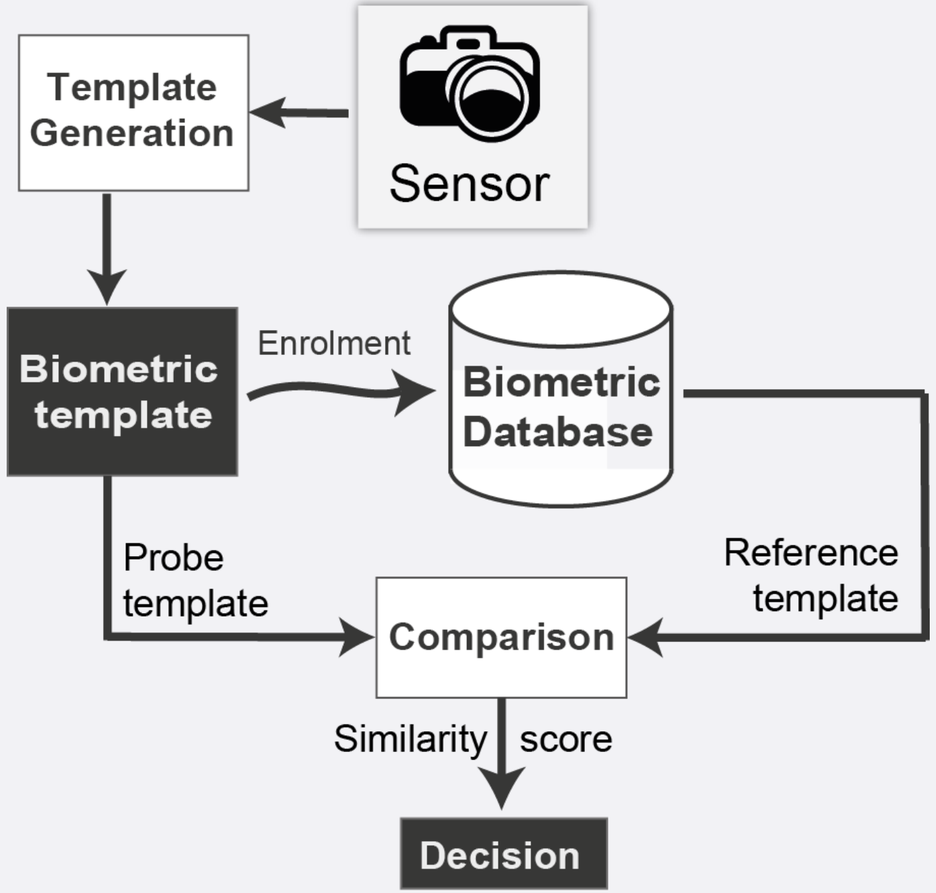
Physical Objects

Recognize or identify various real world objects using internal or external characteristics.

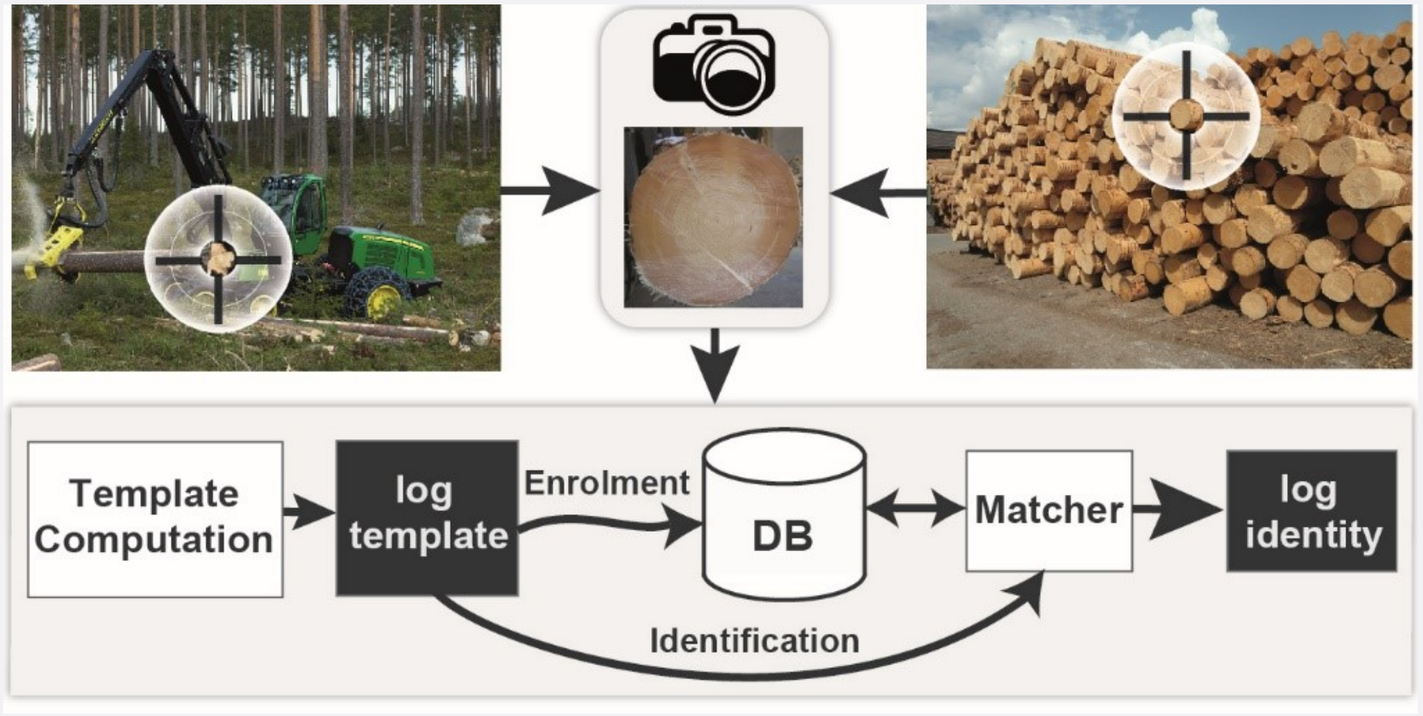
[1] N. R. Council. Biometric Recognition: Challenges and Opportunities. The National Academies Press, Washington, DC, 2010.

Introduction [3/3]
Biometric Systems & Performance Evaluation

- Biometric systems are inherently probabilistic
- Errors can be reduced but not eliminated [1]



Roundwood recognition
Motivation



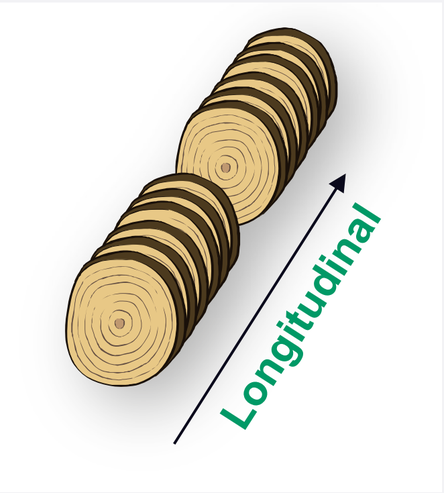
Roundwood recognition
Stability investigations [1/2]

[1] Towards the applicability of biometric wood log traceability using digital log end images

Rudolf Schraml, Johann Charwat-Pessler, Alexander Petutschnigg, Andreas Uhl (2015)

[2] Temporal and longitudinal variances in wood log cross-section image analysis

Rudolf Schraml, Johann Charwat-Pessler, Andreas Uhl (2014)



Roundwood recognition
Stability investigations [2/2]

The similarity between two cross-sections decreases if the time interval or longitudinal distance increases.

Temporal and Longitudinal variations

Roundwood recognition is robust to cutting off slices up to 5 cm in thickness, even if the second cut in the sawmill is performed with another cutting tool.

Surface and Longitudinal variations

Roundwood recognition
Distinctiveness investigations [1/4]

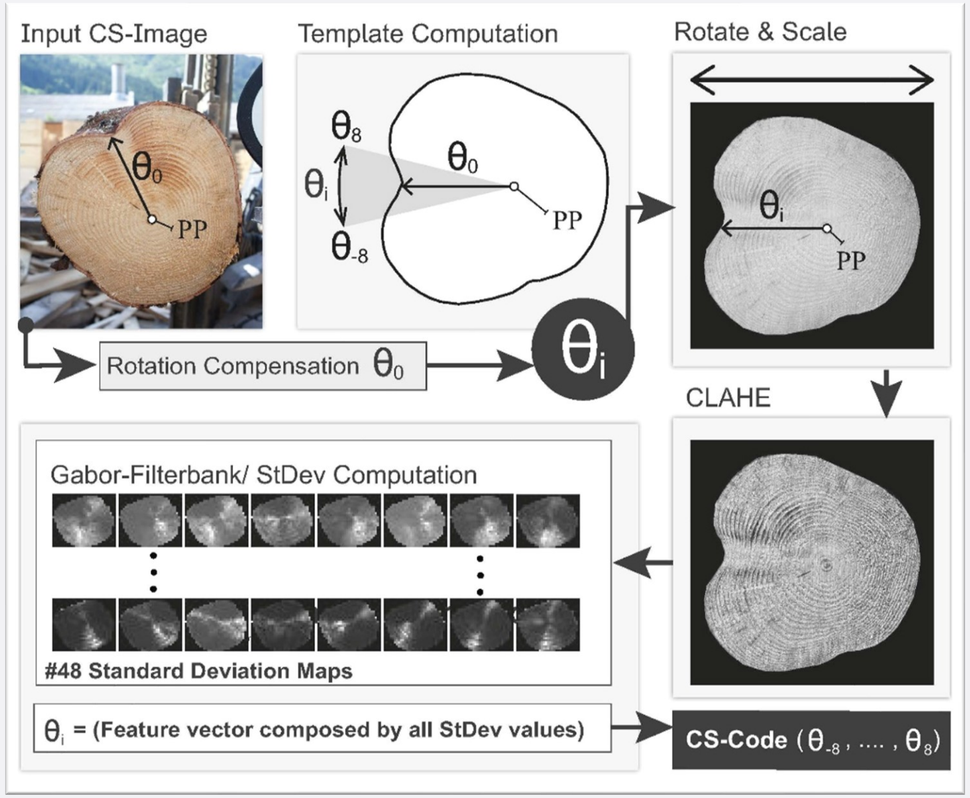
[1] Validation and Reliability of the Discriminative Power of Geometric Wood Log End Features
Rudolf Schraml, Alexander Petutschnigg, Andreas Uhl (2015)

[2] Tree Log Identification Based on Digital Cross-Section Images of Log Ends Using Fingerprint and Iris Recognition Methods
Rudolf Schraml, Heinz Hofbauer, Alexander Petutschnigg, Andreas Uhl (2015)

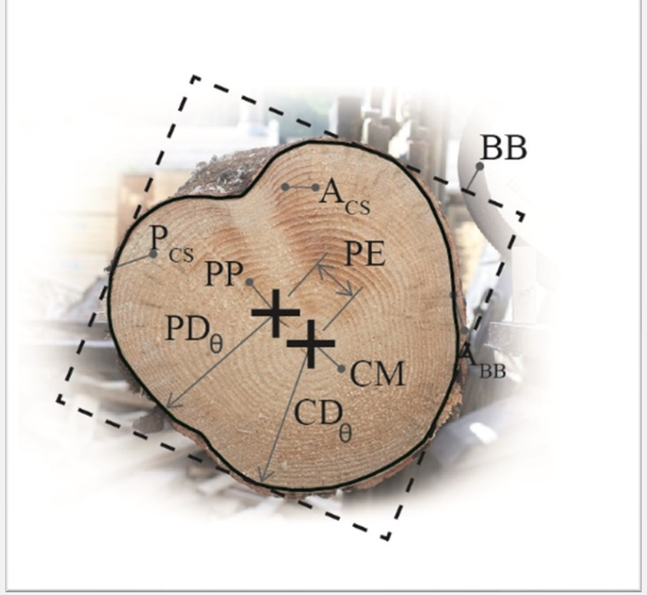
[3] On rotational pre-alignment for tree log end identification using methods inspired by fingerprint and iris recognition
Rudolf Schraml, Heinz Hofbauer, Alexander Petutschnigg, Andreas Uhl (2016)

[4] Matching Score Models for Hyperspectral Range Analysis to Improve Wood Log Traceability by Fingerprint Methods
Rudolf Schraml, Karl Entacher, Alexander Petutschnigg, Timothy Young, Andreas Uhl (2020)

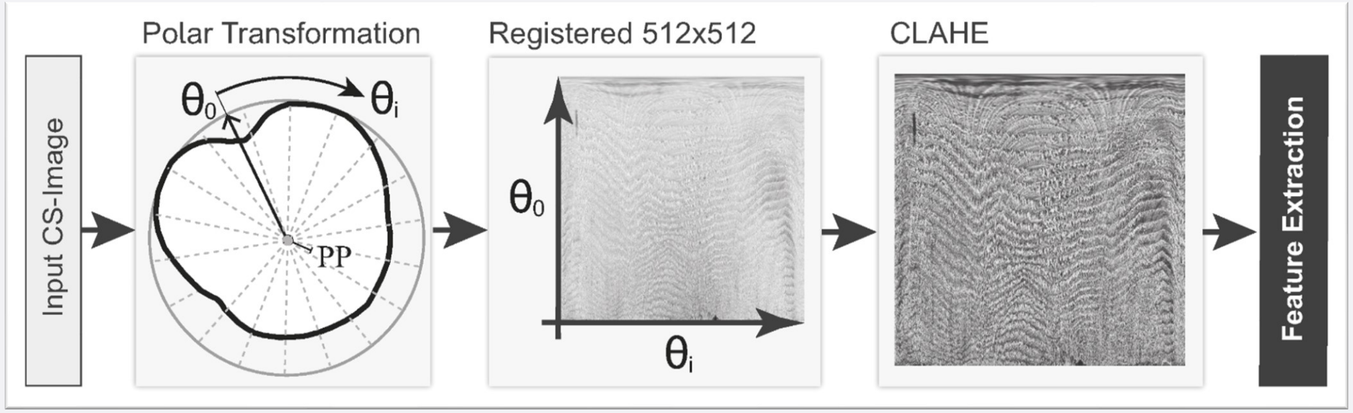
Roundwood recognition
Distinctiveness investigations [2/4]



Fingerprint-based approach

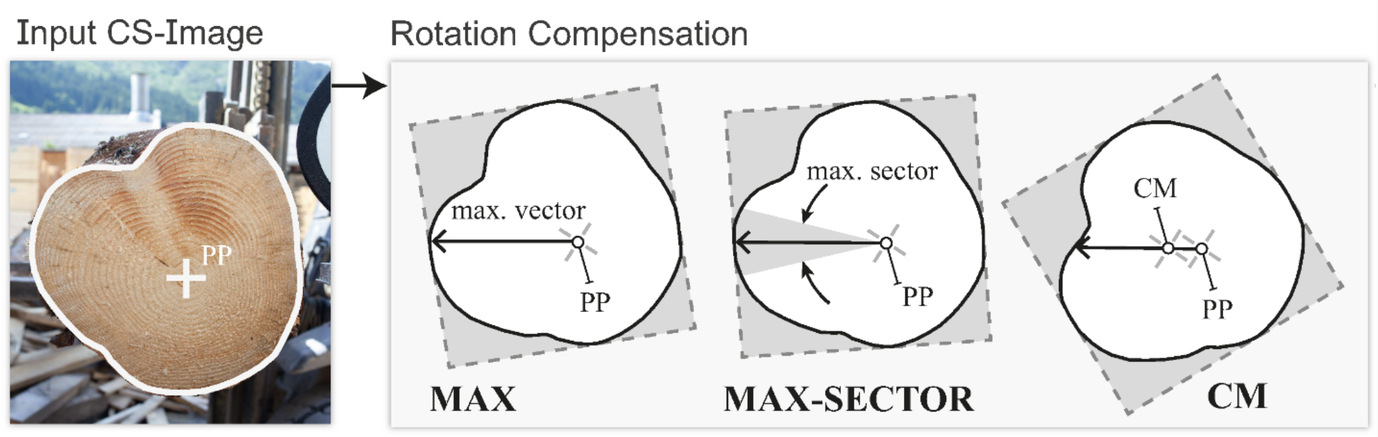


Geometric features



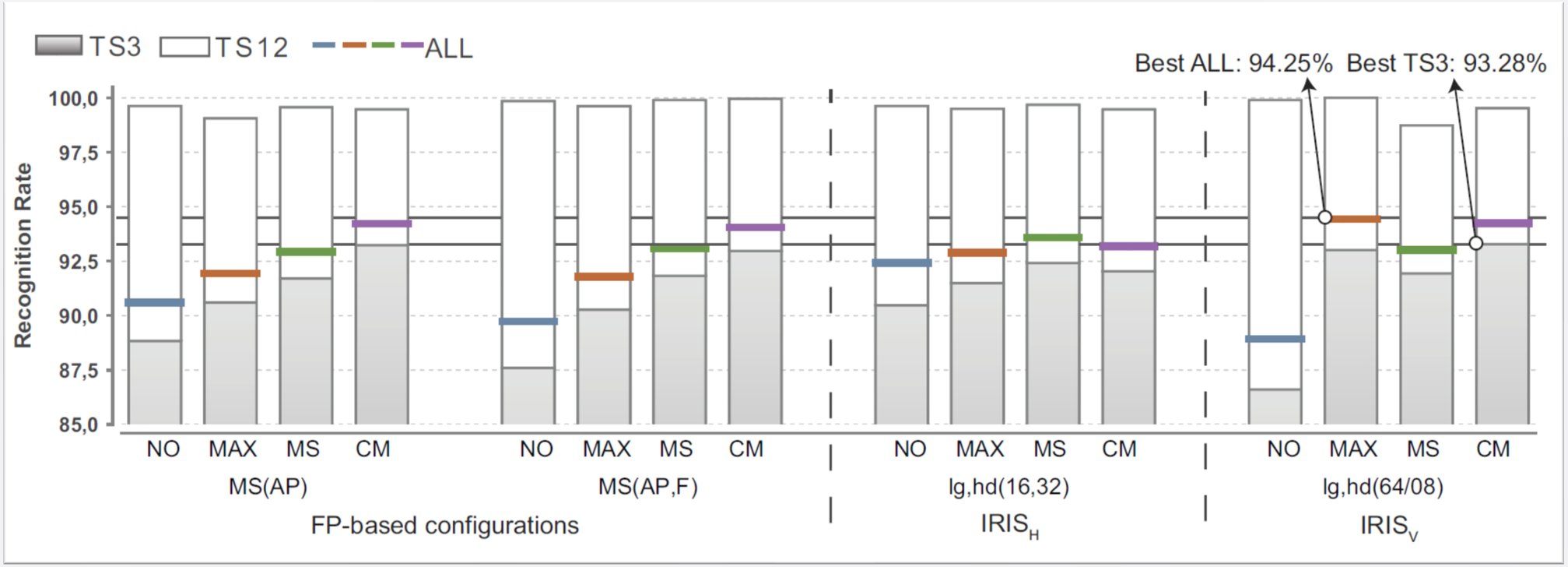
Iris-based approach

Roundwood recognition
Distinctiveness investigations [3/4]

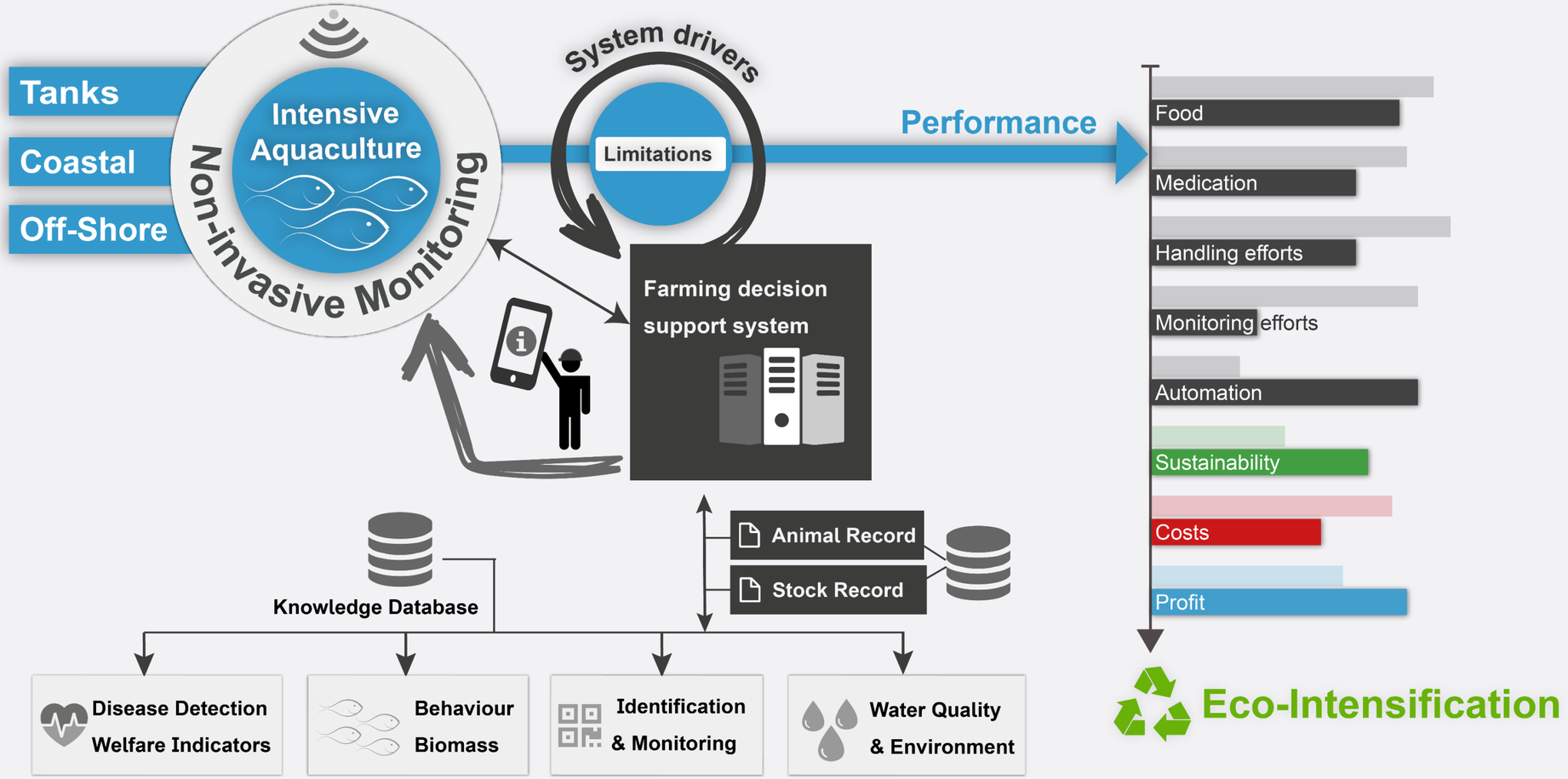


Rotational Pre-alignment

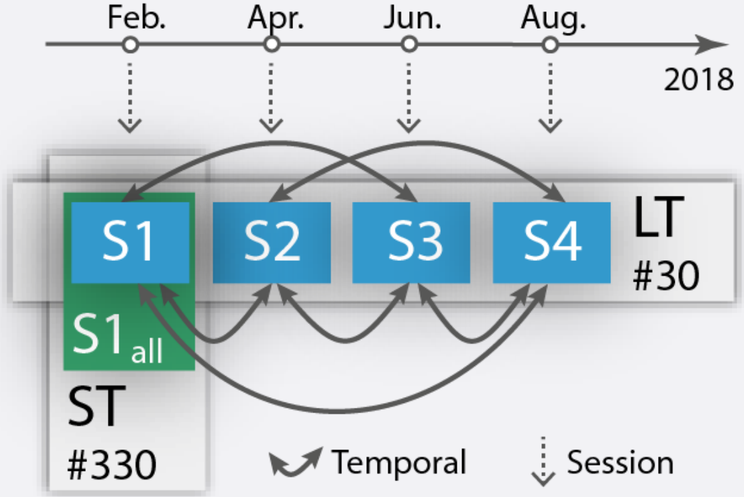
Roundwood recognition
Distinctiveness investigations [4/4]

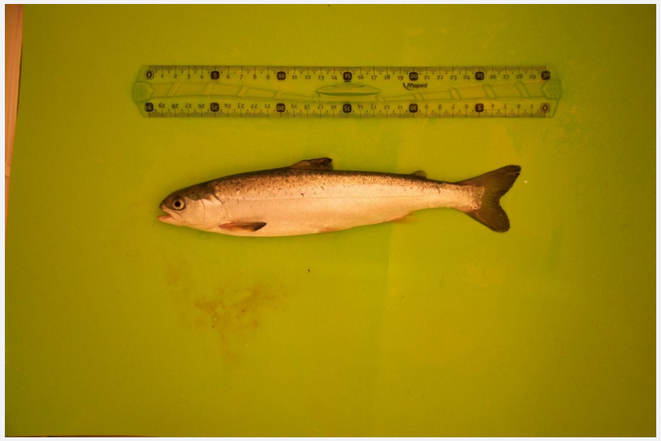


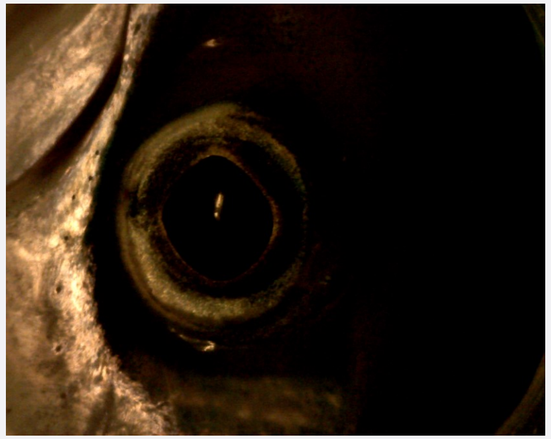
Fish Identification
Motivation



Fish Identification
Image Acquisition



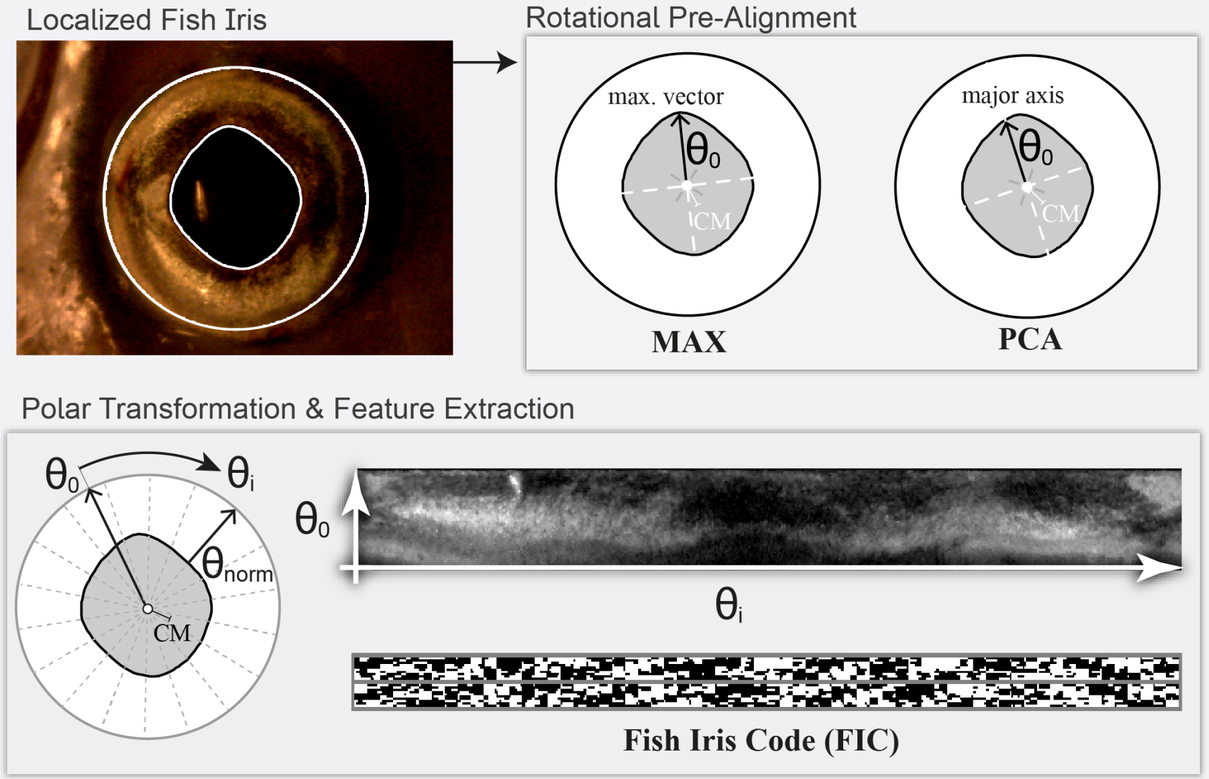




Fish Identification
Iris Identification [1/2]

[1] Towards fish individuality-based aquaculture

Rudolf Schraml, Heinz Hofbauer, Ehsaneddin Jalilian, Dinara Bekkozhayeva, Mohammadmehdi Saberioon, Petr Cisar, Andreas Uhl, 2020



Fish Identification
Iris Identification [2/2]

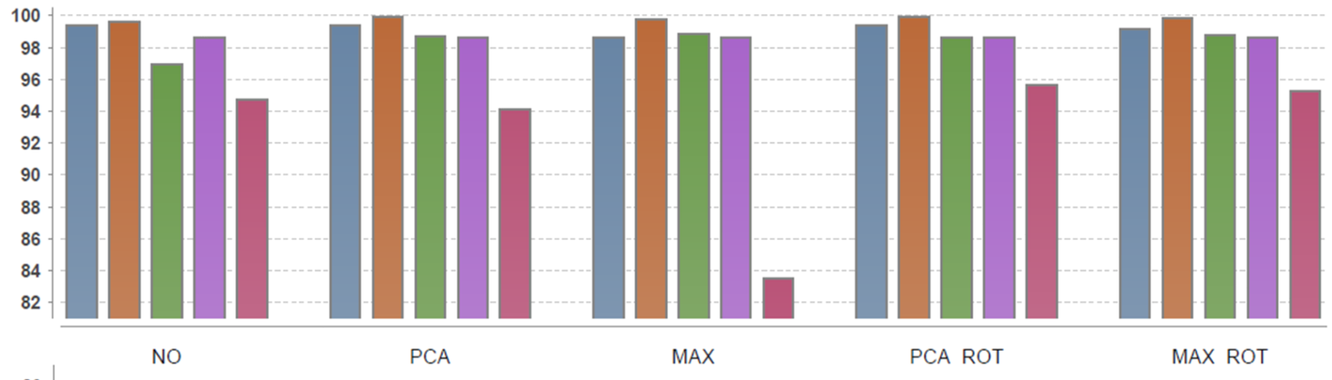


Fig. 10: Session SDs (CNN, SHIFT 16) – Identification performance evaluation [Y-Axis: Rank-1 recognition rate %]

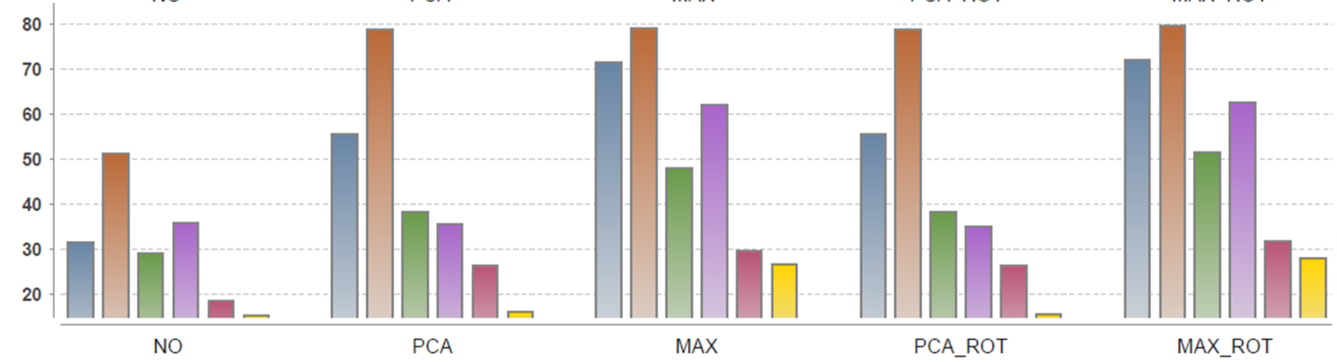


Fig. 11: Temporal SDs (CNN, SHIFT 16) – Identification performance evaluation [Y-Axis: Rank-1 recognition rate %]

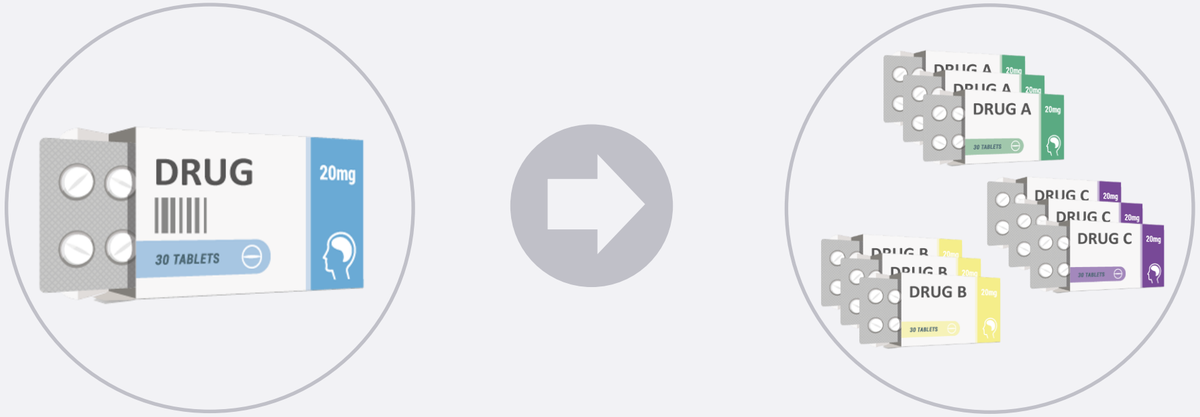
The Atlantic Salmon iris is highly distinctive but it shows a weak stability due to ageing effects.

Drug packaging authentication
Motivation

2013: *5% counterfeited products on EU level → faked medicals are a threat for the patients and cause an economic loss.*

The Falsified Medicines Directive (FMD) should be implemented until 2018. The current solution relies on product ***serialization*** *and tracking using unique numeric identifiers.*

Drug packaging authentication
Basic idea



serialization

Individualize each instance of a product using unique identifiers or PUF-based approaches, e.g. fibre fingerprints

classification

Use intrinsic or extrinsic features which are constant across all instances but different to features from other products.

Drug packaging authentication
Contributions [1/5]

[1] Towards Drug Counterfeit Detection Using Package Paperboard Classification
Christof Kauba, Luca Debiasi, Rudolf Schraml, Andreas Uhl (2016)

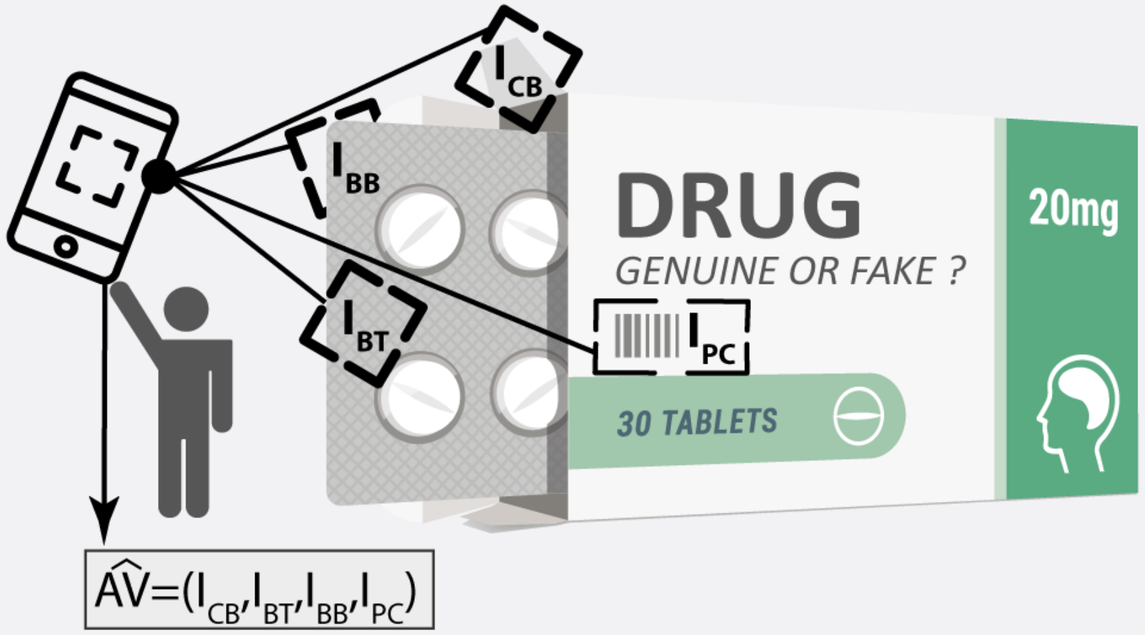
[2] On the feasibility of classification-based product package authentication
Rudolf Schraml, Luca Debiasi, Christof Kauba, Andreas Uhl (2017)

[3] Real or Fake: Mobile Device Drug Packaging Authentication
Rudolf Schraml, Luca Debiasi, Andreas Uhl (2018)

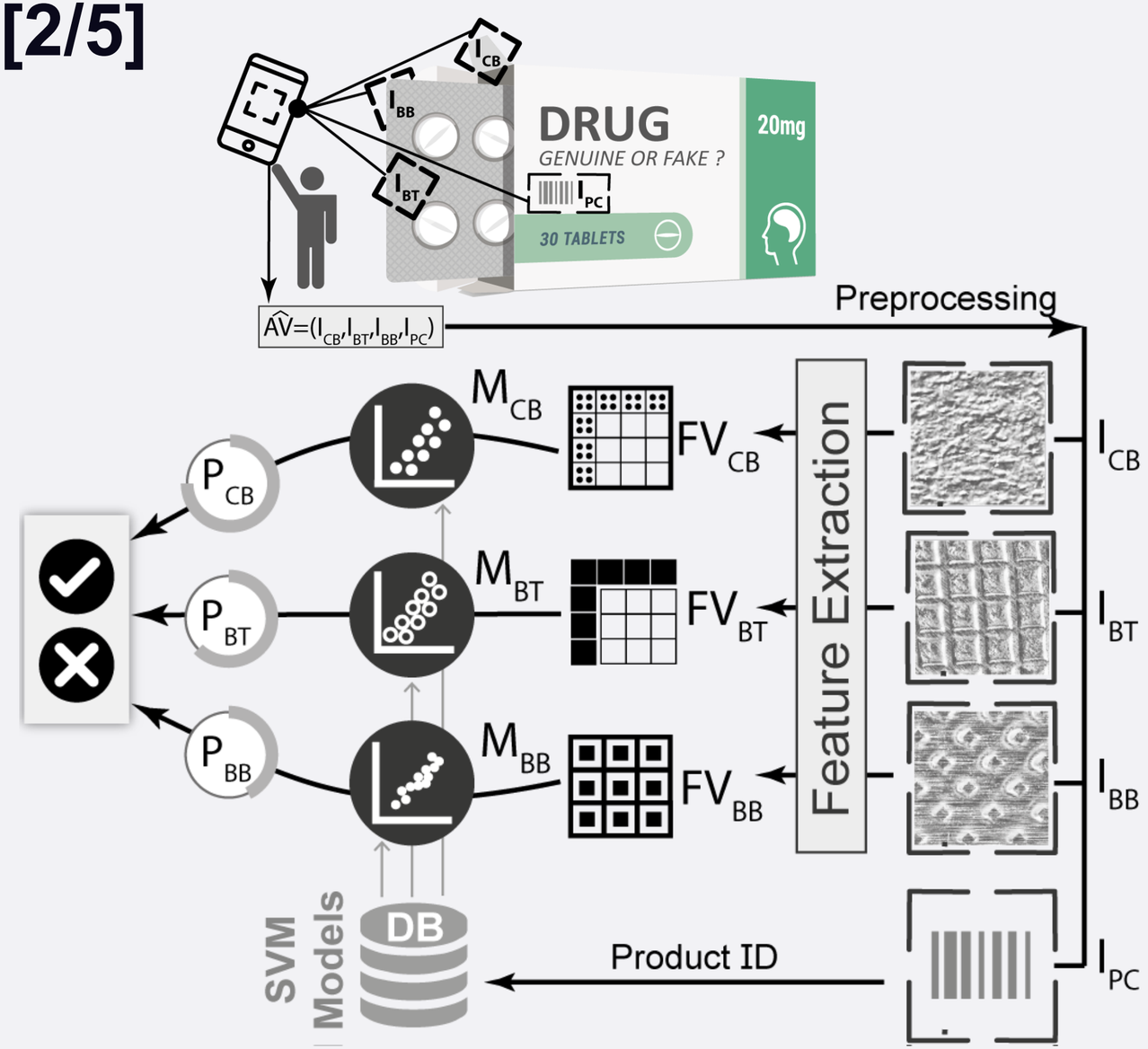
Capture packaging modalities:

CB = Cardboard
BB = Blister Bottom
BT = Blister Top

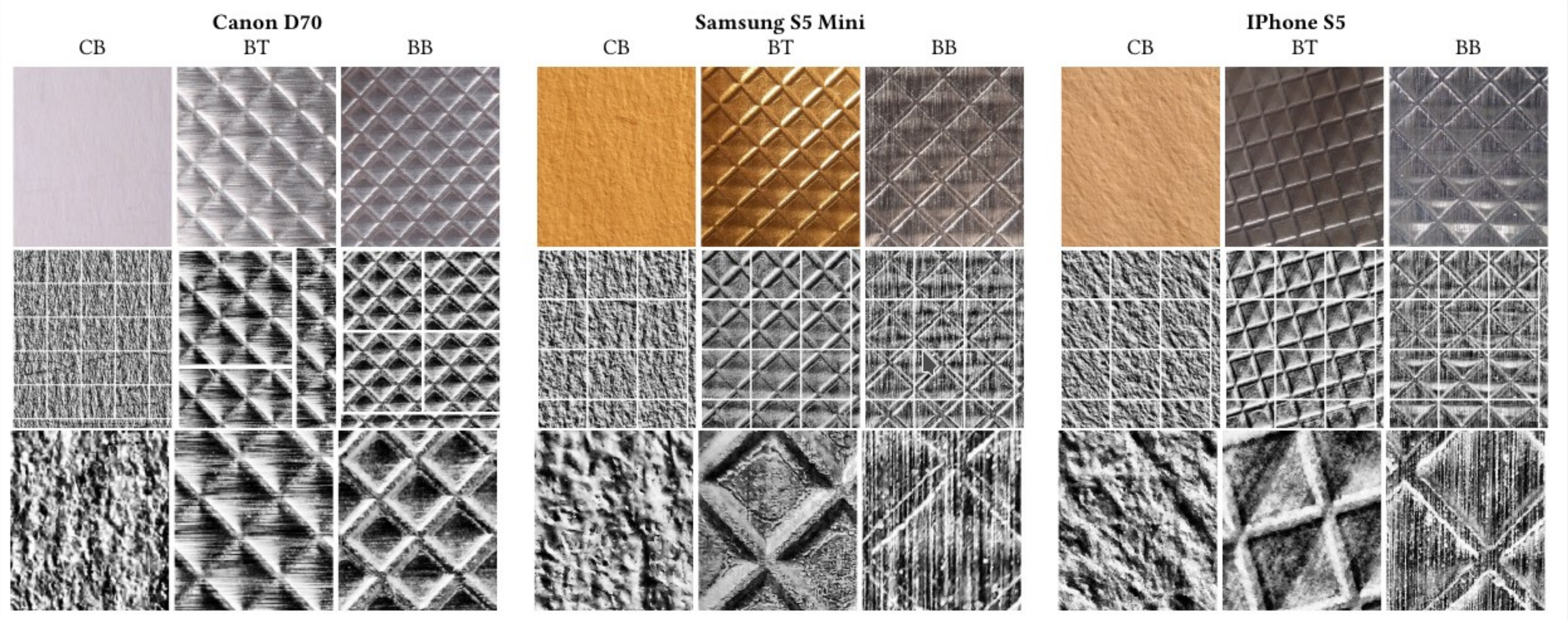
& the product code (PC)



Drug packaging authentication
Contributions [2/5]



Drug packaging authentication
Contributions [3/5]



Drug packaging authentication
Contributions [4/5]

Instance invariance

Textural features of drug packaging material are constant and highly discriminative.

Instance generalistation

Experiments indicate that a classifier can be trained with a set of known instances and is able to authenticate unseen instances.

Modality fusion

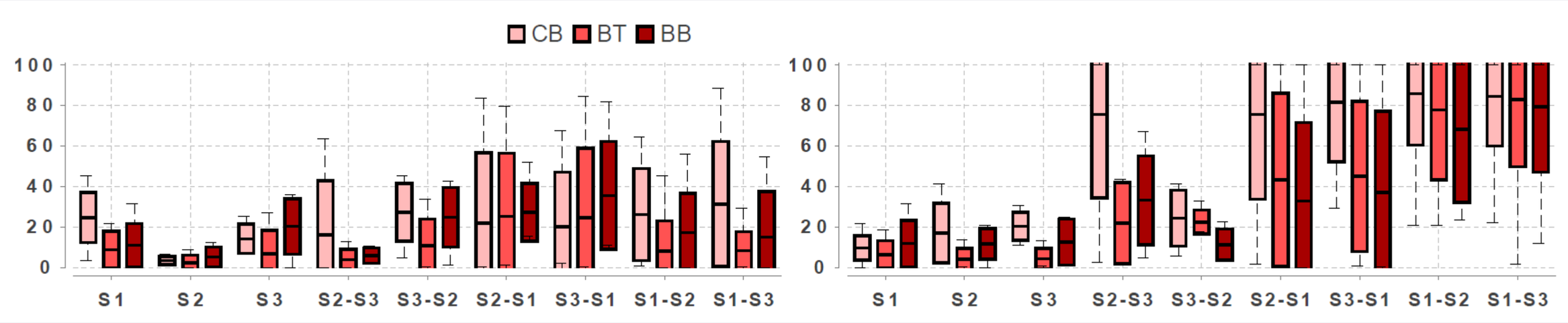
Modality fusion improves the authentication performance.

Mobile-device based authentication

Images captured with mobile devices are suited for classification-based packaging authentication.

Drug packaging authentication
Contributions [5/5]

FISHER L-SVM (Best Features):
Y-Axis: Single sensor, Cross-sensor scenario



False Positive Rates: $FPR[\%] = \frac{FP}{TN+FP}$

False Negative Rates: $FNR[\%] = \frac{FN}{TP+FN}$

Cross-sensor scenario

Current approach is not suited for a real-word cross-sensor scenario

Conclusion
Physical Object Identification and Authentication Applications

01

- Demonstrated the applicability of fingerprint and iris recognition approaches.
- Investigated the stability of the annual ring pattern with respect to longitudinal, temporal and surface variations.
- Introduced and assessed rotational pre-alignment strategies.

Roundwood Recognition

02

- Demonstrated the principal feasibility of Atlantic salmon fish identification using iris images.
- A fully automated system for iris image processing has been proposed.
- Short and Long term experiments were presented.

Fish iris identification

03

- Demonstrated the feasibility of classification-based drug packaging authentication.
- Proposed a new authentication system.
- Single and cross-sensor experiments were performed.

Drug packaging authentication

TreeTrace AquaMonit

Open Challenges & Outlook
Physical Object Identification and Authentication Applications

Consider realisitic data acquisition.

Deep Learning-Based Approaches

thank you.