Authentication

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Lecture 4:

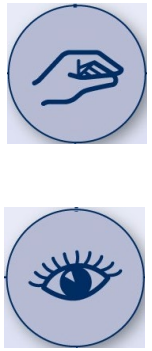
Application: Efficient Image Processing System for an Industrial Machine Learning Task[1]

[1] K. Vukovic, K. Simonis, H. Dörksen, V. Lohweg, in: Conference on Machine Learning for Cyber-Physical Systems (ML4CPS), Fraunhofer Application Centre IOSB-INA, Lemgo, 2015.

OUTLINE

1) Introduction: Industry 4.0 & CPS

2) Concept of *Perceptive Motor*



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3) Application: Knitting Assistance System

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knitted-fabric-manufacturing-process

4) Conclusion and 5) Outlook

1) INTRODUCTION: INDUSTRY 4.0 & CPS

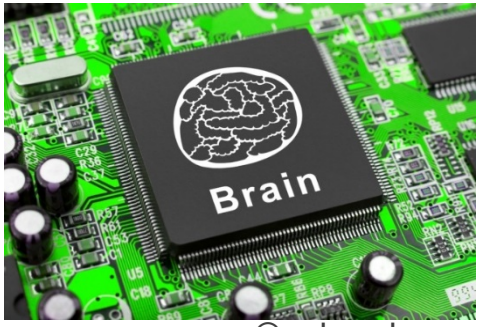
– We concentrate on processes in which numerous actuators and sensors (many hundreds up to thousands) are applied.

1) INTRODUCTION: INDUSTRY 4.0 & CPS

Cyber-physical System (CPS) is complex system of collaborating elements

<u>Challenges:</u>

- Artificial Intelligence
- Time Efficiency
- Cost Efficiency



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2) CONCEPT OF *PERCEPTIVE MOTOR*

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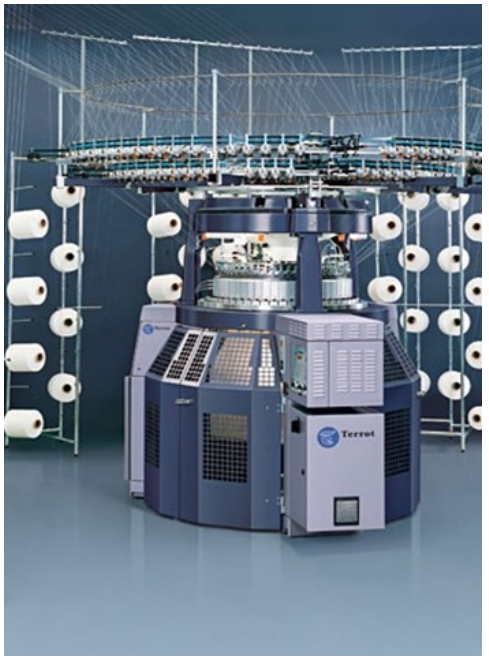
meets CPS challenges:

- Artificial Intelligence
- Time Efficiency
- Cost Efficiency

3) APPLICATION: KNITTING ASSISTANCE SYSTEM



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on base of *perceptive motors* we perform:

- motor condition monitoring
- assistance for set-up parameters
- textil quality monitoring

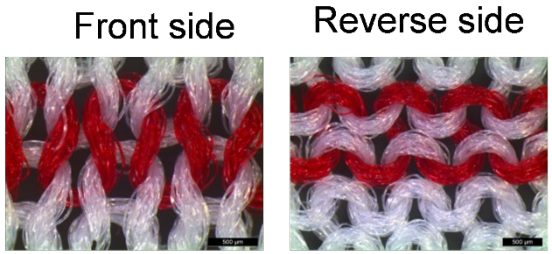
we need:

- technical equipment: sensors (*feeling*: motor itself [1]; *seeing*: image processing system/camera system)

- signal/image analysis tool: Machine Learning fundamentals

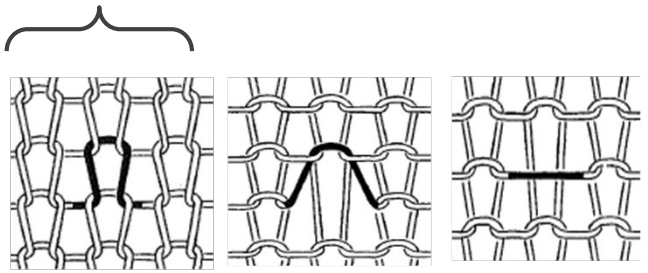
[1]C. Bayer, M. Bator, U. Mönks, A. Dicks, O. Enge-Rosenblatt, and V. Lohweg, “Sensorless Drive Diagnosis Using Automated Feature Extraction, Significance Ranking and Reduction,” in 18th IEEE Int. Conf. on Emerging Technologies and Factory Automation (ETFA 2013), C. Seatzu and R. Zurawski, Eds. IEEE, 2013, pp. 1–4.

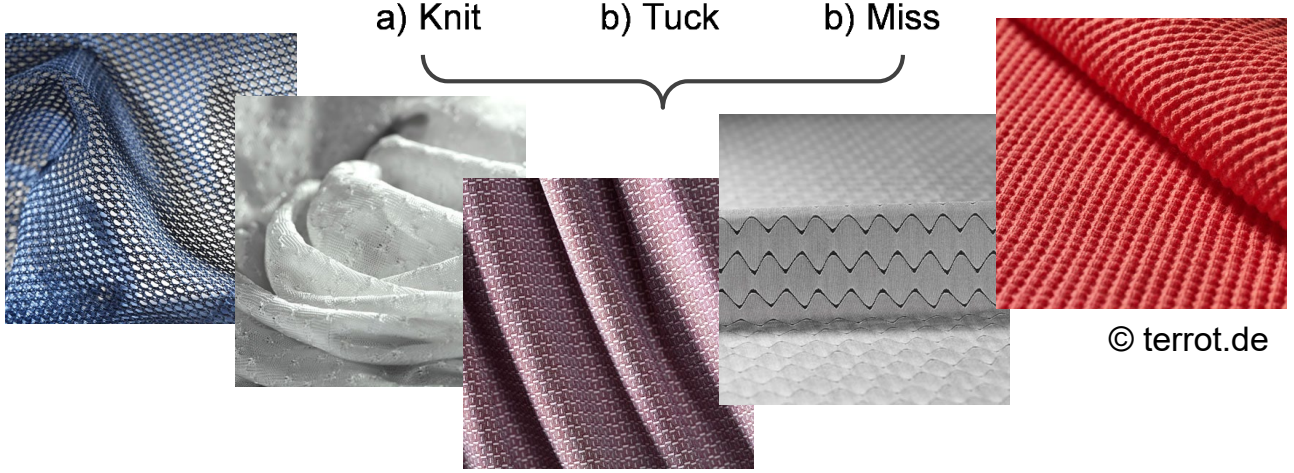
3) APPLICATION: KNITTING ASSISTANCE SYSTEM



d) Light microscopy picture
(Knit elements)

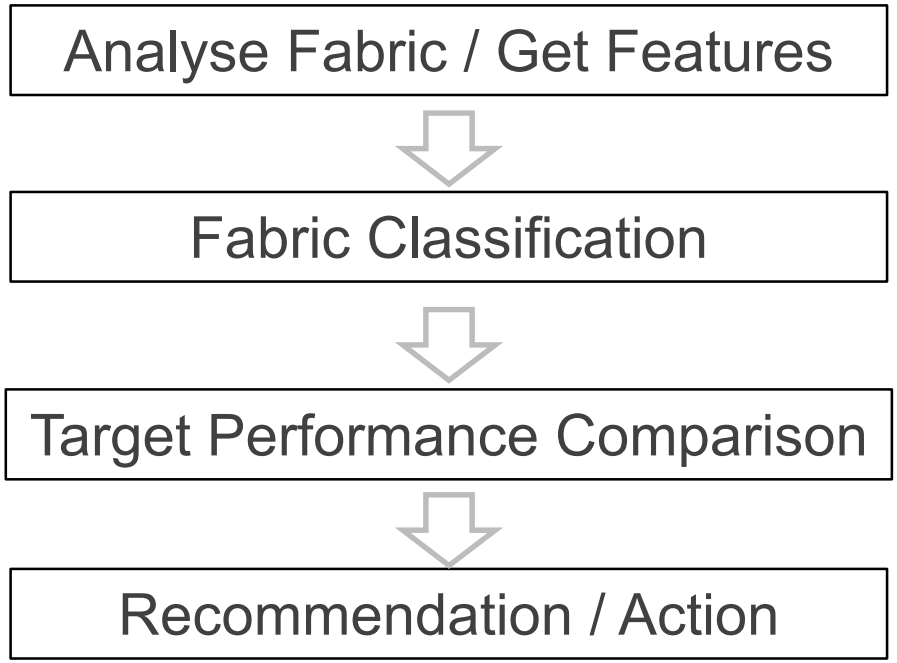
- Medical textiles
- Automotive fabrics
- Technical textiles
- Sport- and Leisurewear
- Underwear & Swimwear





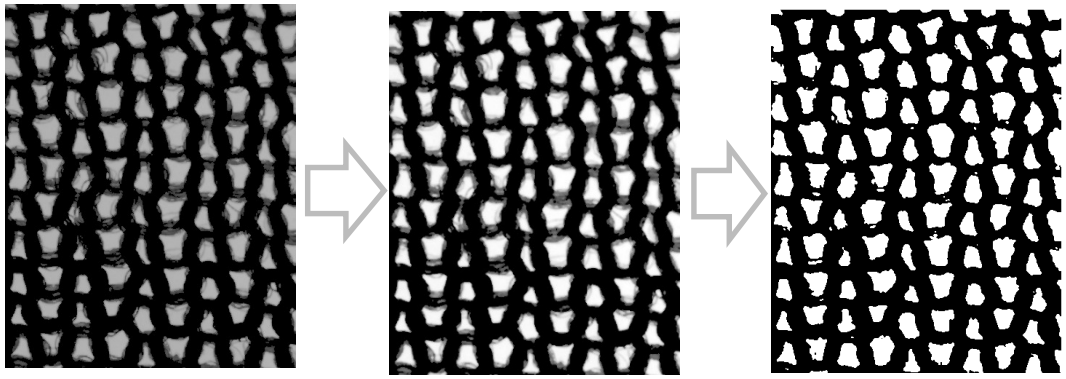
3) APPLICATION: KNITTING ASSISTANCE SYSTEM

Workflow of system:



3) APPLICATION: KNITTING ASSISTANCE SYSTEM

Image Processing Chain:

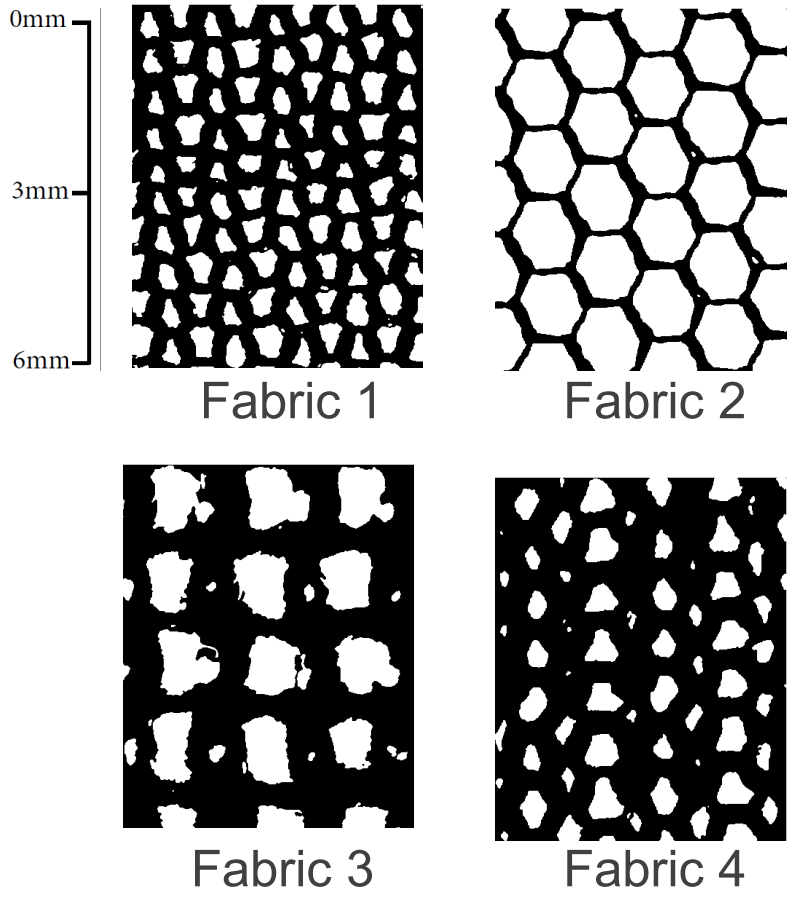


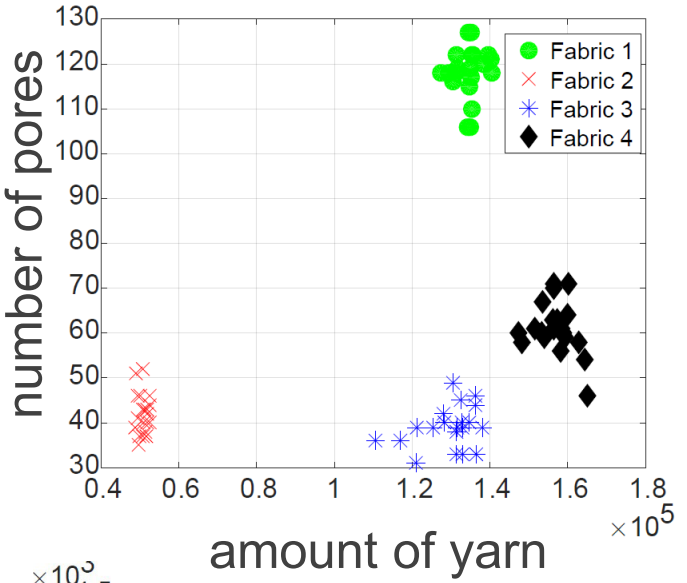
- Diffuse backlight is used (avoids shadows & reflections)
- Surrounding illumination is negligible
- Low-level image processing methods are applied (de-noising, auto-contrast)
- Image segmentation by Otsu‘s method[1]

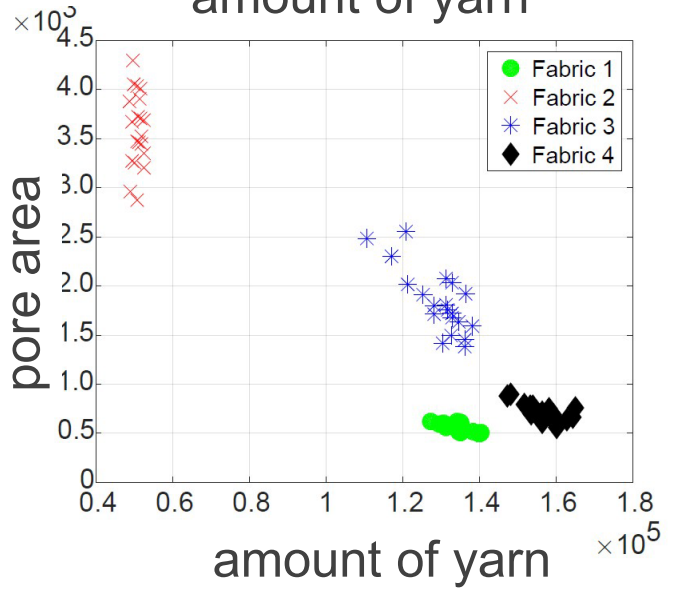
[1]N. Otsu, A Threshold Selection Method from Gray-Level Histogramms. Tokyo, Japan: IEEE Xplore, 1979.

3) APPLICATION: KNITTING ASSISTANCE SYSTEM

Get Features for Fabric Classification:







3) APPLICATION: KNITTING ASSISTANCE SYSTEM

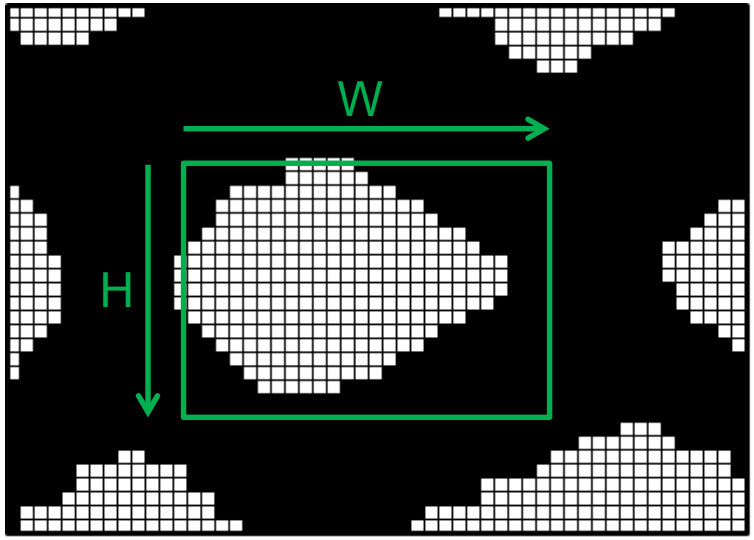
Evaluation of Fabric Classification:

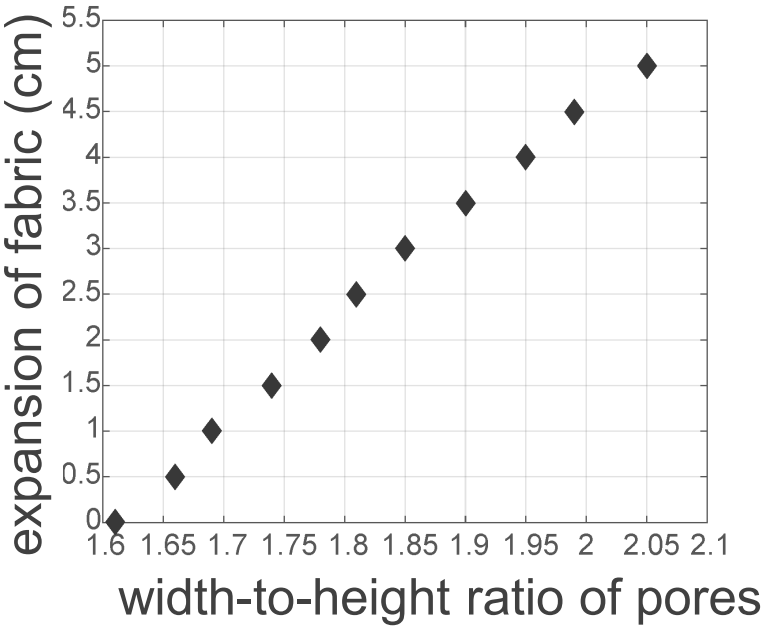
Classifier	Accuracy	Standard Deviation
Naïve Bayes	100%	+/- 0%
Support-Vector Machine	81,25%	+/- 6,25%
Decision Tree	98,75%	+/- 3,75%
3-Nearest-Neighbours	92,50%	+/- 8,29%

3) APPLICATION: KNITTING ASSISTANCE SYSTEM

Measuring Quality of Fabric:

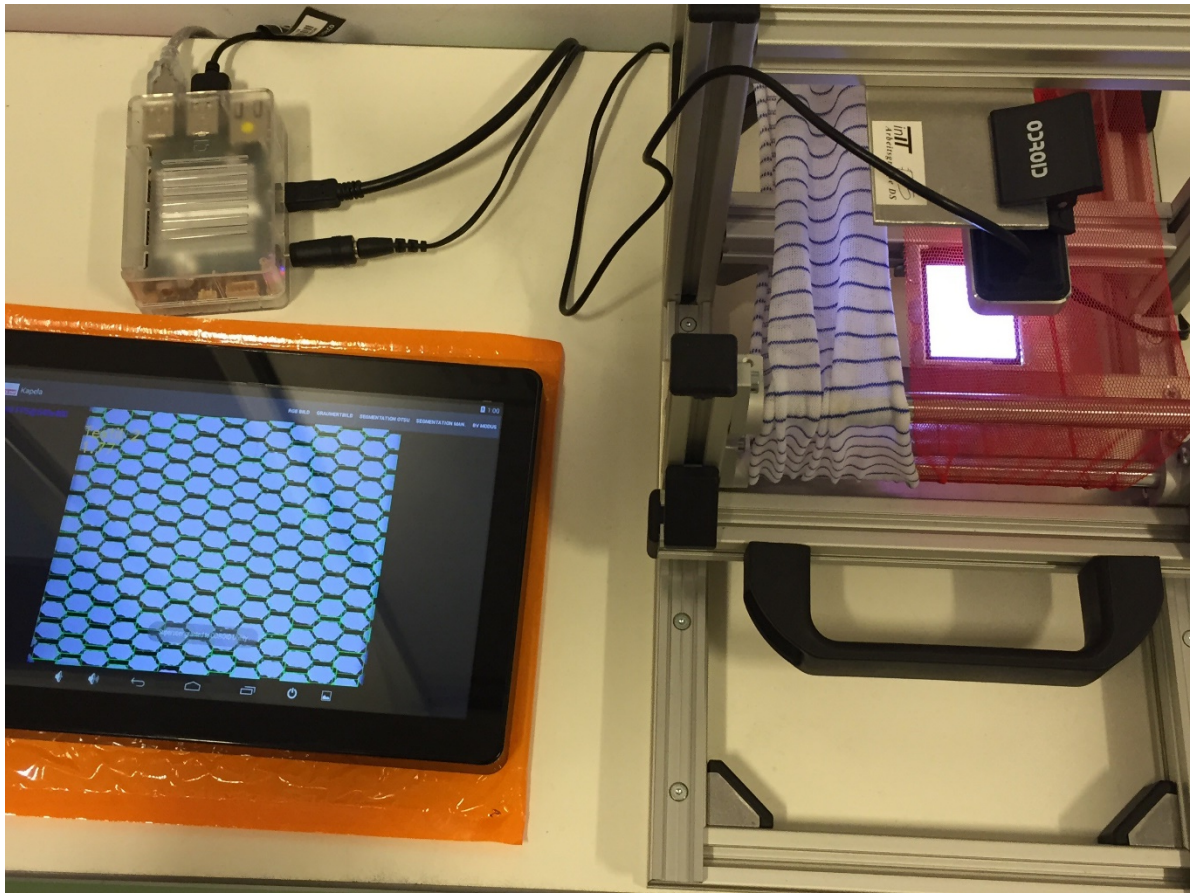
quality parameter – „**Expansion**“ : If a textile is stretched, the pore size increases. Perpendicular to that direction, the pore size decreases, i.e. **expansion** of the material can be measured by the **width-to-height** ratio of the pore.





3) APPLICATION: KNITTING ASSISTANCE SYSTEM

Demonstrator (visual part):



4) CONCLUSION

CPSs:

- ✓ A concept of *perceptive motor* is presented (*feeling* and *seeing* motor)
- ✓ It meets challenges:
  - → Artifitial Intelligence
  - → Time Efficiency
  - → Cost Efficiency

Application Scenario:

- ✓ An approach for *„Knitting Assistance System“* is shown
- ✓ It combines machine learning and image processing tools:
  - → suitable illumination concept
  - → segmentation method
  - → fabric classification

- ✓ „Expansion“ as quality parameter for knitting process can be measured

5) OUTLOOK

- implementation of approach on resource-efficient hardware
- extention of approach functionalities (e.g. defect detection)
- resourse-efficient hardware implementation of perceptive motor

Summary

in this lecture one application scenario, where authentication methods play important role, is presented

theoretical topics appeared (some are learned before, some are new):

- image segmentation
- feature extraction
- classifiers:
  - ✓ naïve Bayes
  - ✓ support-vector-machine
  - ✓ decision tree
  - ✓ 3-nearest-neighbours

Homework: Exercises and Labs

for the next week prepare practical exercises and labs from **Exercises Lec 4** (you will find it in the donwload area)