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SFB 876 Providing Information by Resource-Constrained Data Analysis

Project B2 (Transfer project)

Resource-aware real-time analysis of artefact afflicted image sequences for the detection of nano-objects

Dr. Roland Hergenröder, Dr. Frank Weichert

Problem

Algorithms, methods, and technical concepts for pharmaceutical quality control and in-process control of medical and biological processes

Application scenarios

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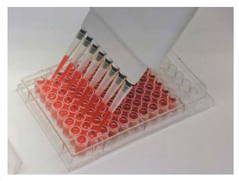
Quality control in the production of vaccine-carrying VLPs



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Quality control of blood donations and blood products

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Quality control of vaccines and blood on-site or decentralised facilities

Challenges phase 3

- Detection quality, energy, memory
- Communication
- High-throughput detection
- Compact mobile system
- Particle sizes 30-80 nm and new virus types
- Real (contaminated) samples
- Online parameter adaptation and monitoring
- Changing environmental & image characteristics
- High specificity and adaptability
- Self-calibration & automatic (in-)process control
- Easy-to-use system with human factors

Challenges phase 2

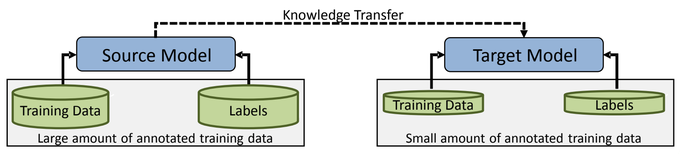
- Detection quality, energy, memory
- Communication
- (Soft) real-time processing
- Mobile system
- Particle sizes 80-200 nm
- Realistic samples
- Offline parameter adaptation
- Different established scenarios

Planned Research

Adaptive differentiable algorithms

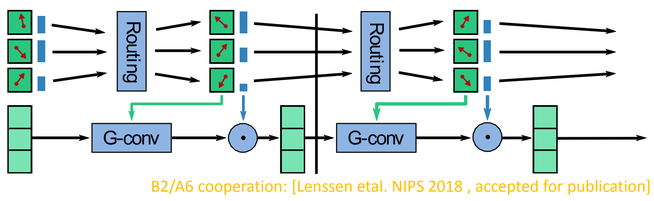
WP 1 Adaptivity in feature learning for changing scenarios

- Transfer learning, mobile adaptive training
- Synthetic training data refinement



WP 2 Efficient, task-specific differentiable algorithms

- Efficient, task-specific DNN modules incorporating background knowledge (C3)
- Processing irregular structured input (A6)
- Task-specific data aggregation methods

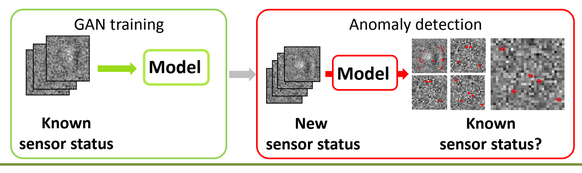


B2/A6 cooperation: [Lenssen etal. NIPS 2018 , accepted for publication]

Adaptive cyber-physical interaction

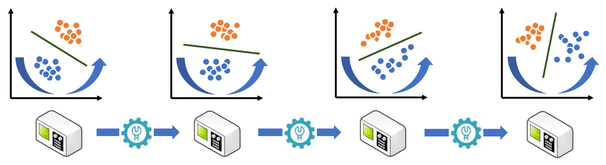
WP 6 Sensor unit online status monitoring

- Convolutional GANs for anomaly detection (A1)
- Online sensor status monitoring for (A4) real-time feedback
- Semantic error classification (B3)



WP 5 Self-organisation of sensor/actuator-units

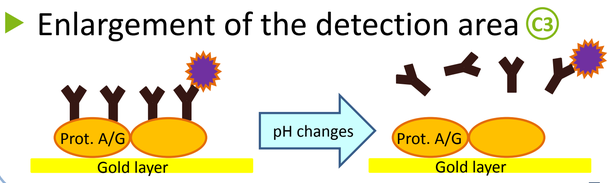
- Self-configuration and self-adaptation
- Contextual learning from demonstrations
- Compensatory methods for concept drift (A3)
- Mobile neural network processing unit (A1)



Functional enhancement of the PAMONO unit

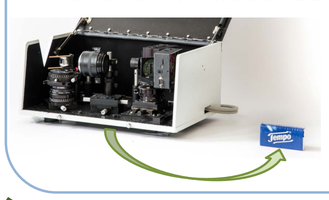
WP 3 Sensor surface functionalisation for medical quality control

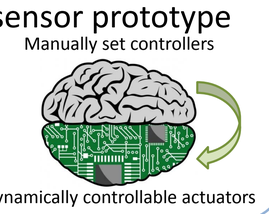
- Blocking procedure, reversible binding
- Vesicle surface multi-marker analysis (C1)
- Enlargement of the detection area (C3)



WP 4 Conversion into an adaptive sensor/actuator sensor unit

- Dynamically controllable actuators
- Scattered background reduction
- Reduce the volume of samples required for measurements
- Further miniaturise the sensor prototype





Feedback-/Interaction-loops Feedback-/Interaction-loops

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- Vaccine-carrying VLPs
- Method for cross-validation (e.g. Direct ELISA)
- On-site evaluation of the PAMONO technology in vaccine processes

WP 7 Evaluation of the PAMONO technology for quality control of medical products

- Creation of evaluation and working scenarios (in the lab/in the field)
- Real-time hybrid structural testing
- Context-aware optimisation of DNNs inference algorithms
- Estimate critical parameters under stationary and "stress" conditions

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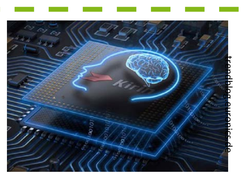
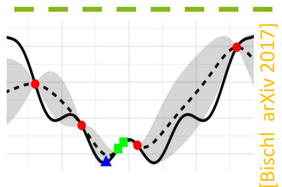
- Reference samples and standards
- Evaluation of the PAMONO technology for clinical routine screening
- Collaboration with manufacturers of blood products and with blood donation services

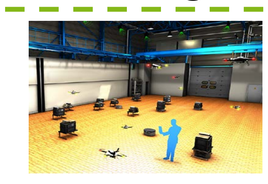
Integration within the **Collaborative Research Centre**



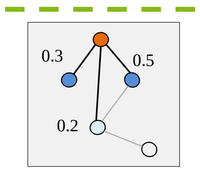
(A1) Neural network processor integration and optimisation



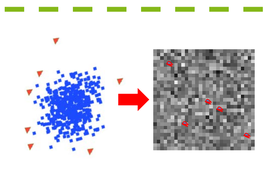
(A3) Global optimisation, concept drift [Bischl arXiv 2017]



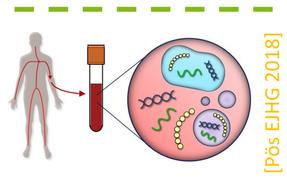
(A4) Resource-aware heterogeneous platforms



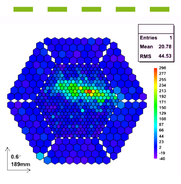
(A6) Efficient DNNs for irregularly structured data



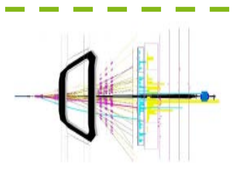
(B3) Anomaly detection, online monitoring



(C1) Monitoring technique for liquid biopsies [Pös EJHG 2018]



(C3) Analysis of FACT data, enlarging the PAMONO detection field



(C5) Analysis of high-dimensional and highfrequent data

isas Biomedical Research **Interface Processes**

Computer Science 7 **Computer Graphics**

ARTES **Biotechnology GmbH**

Paul-Ehrlich-Institut **Transfusion Medicine**