Human-Machine Interaction

Intensification of separation processes in the food industry through digital twins and intelligent process control

Data-driven and model-based methods are combined to optimize production processes by creating hybrid digital twins, which can predict the production process and its influencing and output variables. Prediction is based on collected process data and existing expert knowledge as well as formalized physical/empirical models. This allows online optimization at production time and thus enables more sustainable process control.

Human-centered creation and evolution of digital twins in process industry

Digital twins and new interaction technologies such as mixed reality offer the potential in industrial applications to provide goal-oriented support to human experts and thus optimize processes. In process technology, both concepts are still in their infancy. Reasons are the need for the evolutionary capability of digital twins, special requirements using devices in the field, and the heterogeneous database. MEvoDiP addresses this research gap and analyzes the use of AR/VR in interaction with digital twins to enable a new human-centered evolution in the field.

Institute of Automation and Information Systems
Technical University of Munich

Our Areas of Expertise

- Evolvable Industrie 4.0 architectures
- Analysis of Big and Small Data to model cause-effect relationships, extract "hidden" information and optimize technical systems in a data-driven manner
- Digital twins to provide tailored support for human experts
- Maintainability management in variants
- Inconsistency management and optimization across development models from different stakeholders
- Quality assessment of control software
- Benchmarking of control and communication systems

Cooperation

We offer the following cooperation opportunities:

- Sponsored research projects such as the BMWK, BMBF, EU commission, Bavarian Ministry of Education and Culture, Science and Art, ZVEI, DFAM, DFG
- Research and development mandate

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Institute of Automation and Information Systems
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SPS 2022

smart production solutions

Nuremberg, Germany 8.-10. November 2022

Institute of Automation and Information Systems

Main Topics:

- Model-based Development
- Intelligent Manufacturing Systems
- Smart Data in Automated Manufacturing Systems
- Human-Machine Interaction

Visit us at: Hall 7, booth number 580

Research Projects

Model-based Development

System architecture and modular design of robot-like systems using multidimensional characteristic diagrams

DSL4RAS

The main goal of DSL4RAS is the modelling of robot-like systems using multidimensional characteristic diagrams. Therefore, comprehensive knowledge of the properties of the relevant modules is required for the development of novel robotic systems, the optimization of system performance, and their automation-related adaptation to compensate for mechanical effects.

Consistent development of automated material flow systems using a model-based approach

KonMaFS

The development of automated material flow systems is characterized by close collaboration between stakeholders from different disciplines, e.g., mechanics, electrics/electronics and software. Each discipline uses different models, which partly overlap with information from other disciplines, leading to inconsistencies in case of changes. The main goal of the research project is the development of a so-called virtual single underlying metamodel (V-SUMM) to realize a continuous process chain during development, detect inconsistencies between development models at an early stage, and enable the reuse of development models across several areas and projects.

Technical Debt identification and assessment in mechatronic systems using indicators, patterns and metrics

TDebituM

Decisions that yield short-term benefits but prove harmful and costly in the long run are often made because their scope, impact, and corrective measures are not appreciated or are underestimated. This phenomenon is referred to as Technical Debt (TD). TDebituM focuses on identifying TD in mechatronic systems and its evaluation for criticality and consequences, including cross-disciplinary, cross-organizational, and cross-industry characteristics. Using TD indicators, patterns and metrics, TD shall be identified and mastered semi-automatically.

Intelligent Manufacturing Systems

Advanced systems engineering for control software as a prerequisite for flexible, adaptive cyber-physical production systems

advacode

Control software in automated production systems must be maintainable for hundreds of variants of machines and plants over decades. This can only be realized efficiently with the help of an evolvable software architecture, including a clean module structure. advacode addresses this challenge by developing methods that support the quality assessment and the revision of existing control software using refactoring means and, thus, improving its reusability and maintainability.

Developing the first AI Factory in Bavaria. A flagship project of the Bavarian High-Tech Agenda

KI.FABRIK

The Munich Institute of Robotics and Machine Intelligence of the TU Munich launches the first AI.FACTORY in Bavaria (KI.FABRIK in German) as a part of the Hightech Agenda Bavaria. AI.FACTORY differs significantly from previous concepts w.r.t. the direct physical interactions of the factory's decentralized AI cells and their digital twins. Robot systems, metal work stations, 3D -printing, electronic cells, and the factory's intralogistic systems are included. Automated adaptations with regard to Production-as-a-Service is key to a resilient and adaptive future factory.

Design approach for structuring distributed digital twins

DAVID

For the digital accompaniment of highly flexible, cyber-physical production systems, digital twins are used. DAVID supports the development of distributed digital twins as a modular, scalable data structure for mechatronic components and systems.

Enhancement of the Overall Equipment Effectiveness of factories – development of resilient agent-based automation systems for machine and plant manufacturing industry

Resi4MP

Resi4MPM aims at developing a decentralized agent-based method to improve the resilience of production systems, thus increasing a factory's Overall Equipment Effectiveness. This will be achieved by combining intelligent field-level devices with cloud-based data analysis methods from our Taiwanese research partners at NCKU, whose focus is the intelligent predictive maintenance system.

Smart Data in Automated Manufacturing Systems

Causal alarm pattern analysis by the integration of technical information from engineering documents (project CausalITI)

Alarm management systems (AMS) are a crucial part of automated production systems, due to their important role in assuring the systems' safe operation. Causal dependencies between alarm sources increase the number of alarms presented to the operator, leading to so-called alarm floods. By integrating automatically extracted knowledge from engineering documents into historical alarm data analysis, alarm root-cause analysis and detection of causal alarm patterns, improved AMS methods can support the operator by detecting causal alarm patterns.

Self-learning and self-optimizing control of valves and valve systems for hydraulic machines and aggregates

AI Valve

Numerous mobile as well as stationary machines are operated with hydraulic actuators, which are controlled by several hydraulic valves. Within the scope of AIValve, new approaches to self-adjusting, self-learning adjustment of the open-loop/closed-loop control of valves and valve systems for mobile machines are developed in order to allow largely automatic commissioning for universal applications.

Integrating sensor in gear components (project SIZA)

SPP2305

The potential damage of gears results directly or indirectly from the physical processes of tooth engagement. Therefore, the aim of the research is the integration of sensors and electronics including algorithms for data processing at the point of interest (in-situ) in the machine element gear. The data is pre-processed, transmitted to a central system and can thus finally be used to determine the condition of the gear.

Machine operator-centric parameterization of Artificial Intelligence for tightly coupled, distributed, networked control systems

OPAI4DNCS

OpAI4DNCS explores the use of AI at the control level in mobile hydraulic-electric machines using the example of complex drilling rigs and their hydraulic subsystems to accelerate setup and increase the efficiency of operation, especially for inexperienced machine operators.