Research and Teaching at IAS

2018

Prof. Dr.-Ing. Michael Weyrich
History

since 2013
Institute of Industrial Automation and Software Engineering
Professor M. Weyrich

1995 – 2015
Institute of Industrial Automation and Software Engineering
Professor P. Göhner

1970 – 1995
Institute of Control Systems Engineering and Process Automation
Professor R. Lauber

1935 – 1970
Institute of Electrical Installations
Professor A. Leonhard
Institute of Industrial Automation and Software Engineering (IAS)
Faculty of Computer Science, Electrical Engineering and Information Technology of the University of Stuttgart

**Research and teaching** at the Institute focuses on the topic of **Software Systems for Automation Engineering**.

We see ourselves as a **bridgehead to Product and Plant Automation** in the research disciplines of **Information Technology, Software Technology and Electronics**.

Prof Weyrich was appointed to the University of Stuttgart in April 2013.
Information about IAS

- Institute members
  - Head of institute: 1
  - Research staff: 15
  - Faculty support staff: 5
  - Apprentices: 2

- PhD graduates per annum: ~2

- Undergraduate Projects and Diploma-/Master Theses per annum: ~90

- Exams per annum: >>1000

- Publications per annum: 20-25

- Student Assistants per annum: 40-50
Lectures at the Institute

- Industrial Automation I (German)
- Industrial Automation II (German)
- Technologies and Methodologies of Software Systems I (German)
- Technologies and Methodologies of Software Systems II (German)
- Software Engineering for Real-Time Systems
- Industrial Automation Systems
- Introduction to Computer Science II (German)
- Lecture Series: Software and Automation
- Reliability and Safety of Automation Systems (German)
- Software Engineering Internship
- Industrial Automation Internship

Courses for Degree Programmes

- B. Sc. Elektrotechnik und Informationstechnik
- B. Sc. Mechatronik
- B. Sc. Medizintechnik
- B. Sc. Erneuerbare Energien
- B. Sc. Technische Kybernetik
- B. Sc. Technikpädagogik
- B. Sc. Informatik

- M. Sc. Elektrotechnik und Informationstechnik
- M. Sc. Mechatronik
- M. Sc. Medizintechnik
- M. Sc. Information Technology
- M. Sc. Nachhaltige Elektrische Energieversorgung
- M. Sc. Technikpädagogik
- M. Sc. Verkehrsingenieurwesen
Research at IAS
The research of Automation Technology is based on applications in the manufacturing industry, automotive and urban life.

Institute of Industrial Automation and Software Engineering (IAS)
- Intelligent Automation Systems
- Reliability of Industrial Automation Systems
- Complexity control of cyber-physical systems
Research area: Intelligent Automation Systems

Intelligent automation systems offer opportunities in the area of optimization, flexibility and networked information management.

- Autonomous integration of automation components (Self-X)
- Optimization of automation systems based on process data (Machine Learning, Big Data, Data Analytics)
- Distributed control methods for coordination
- Assistance systems to support the engineering process
Research area: Complexity control of cyber-physical systems

Digital twins, networking and cooperation enable novel engineering and work processes. At the same time, the complexity of cyber-physical systems is increasing due to software and IT.

- Model-driven development of distributed plant controls
- Model-based test of dynamically changing software and hardware systems
- Digital twin and its applications
- Human-machine cooperation in a hybrid reality
Research area: Reliability of Industrial Automation Systems
The quality of automated systems in terms of improving reliability and availability is a key issue in automation.

- Assessment and evaluation of the reliability of automated systems in the Internet of Things
- Fault management and automatic reconfiguration to increase availability
- Test of automated systems and anomaly detection
Model processes at IAS

The model processes are used to represent special automation technology and to demonstrate the capabilities of software systems.
DFG-Project FlexA
Flexibility of assembly and handling machines using multi-agent systems

Requirements:
- Methodical support of the planner in the flexibility process
- Generation and evaluation of adaptation options based on given requirements

Core technologies:
- Product-, process-, resource-model of the machine
- Agent-based assistance system

Approach
- Description of the machine using a model, agents represent components of the machine
- Automated evaluation of production requests
- Generation and evaluation of adaptation options using the model of the machine
- Decision support and assistance in the flexibility planning process
DFG-Project GekoProAg
Decentralized Multiphysics simulation of coupled problems

Requirements:
- Intelligent problem decomposition and cooperation for decentralized simulation
- Improvement of the simulation configuration

Core technologies:
- Software agents
- Simulation
- Case-Based Reasoning

Approach
- Separate consideration of different physical effects
- Software agents for the coordination and exchange of boundary conditions
- Optimization of the simulation configuration using case-based reasoning
- Assisting the engineer in performing Multiphysics simulations on networked PCs
DFG-Project DEPIAS
Decentralized self-organized planning of intralogistics systems with the help of agents

Requirements:
- Support of the planner in the rough planning phase of intralogistics systems

Core technologies:
- Multi-Agent System
- Self-organization

Approach
- Planning of material flow systems is modelled as a dialog-based process and applied to an agent system
- Agents represent resources and try to integrate them into the planned material flow system
- Determination of possible constellations for the material flow system to be planned
BMWi-Project EMuDig40
Data analytics in quality assurance

Requirements:
- Analysis of process data for compliance with defined quality characteristics
- Real-time recommendations to the worker

Core technologies:
- PLC-based data acquisition
- Feature extraction
- Data Analytics (online/offline)

Motivation
- Sensor data contains information about the plant and process status and can be used to improve the process quality

Approach
- Systematic extraction of unknown relationships and patterns
- Data acquisition and integration, dimension reduction, data analysis, recommendations
  ➢ Data-driven quality optimization
Digital Twin
Synchronization of digital models with the real manufacturing cell

Requirements:
- Cross-domain synchronization of engineering models with a real manufacturing cell in operation

Core technologies:
- Engineering and simulation models
- Robot / PLC code analysis
- Decision Tree in Assistance System

Approach
- Discipline-specific change detection in automation technology (anchor points)
- Consistency check between detected anchor points using a decision tree
- Software-assisted synchronization of changes in the Digital Twin
- Time and cost savings in engineering during the operational phase
Cooperation with the following companies

- AUDI AG
- Daimler AG
- Deutsche Accumotive GmbH & Co. KG
- Hirschvogel Umformtechnik GmbH
- iss (Innovative Software Services GmbH)
- Robert Bosch GmbH
- Siemens AG
- SMS group GmbH
- Vector Consulting GmbH
- Vector Informatik GmbH
- OTTO FUCHS KG
### Maker Space
IAS supports various start-up companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
<th>Duration</th>
<th>Funding Agency</th>
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<tbody>
<tr>
<td>EKU</td>
<td>Create technologies that combine power generation with efficient control systems.</td>
<td>Juni 2014 – Mai 2015, Juni 2015 – Mai 2016</td>
<td>EXIST, Junge Innovatoren</td>
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Thank you!

Prof. Dr.-Ing. Michael Weyrich

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