Institute of Industrial Automation and Software Systems (IAS)

Prof. Dr.-Ing. Michael Weyrich
2015
Research and Teaching at IAS

History

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

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

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

1935 – 1970
Institute of Electrical Installations
Professor A. Leonhard

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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. The institute is lead collegially with Prof. Göhner who will retire in September 2015.
Information about IAS

- Employees
  - Research Assistants: 4
  - Research staff: 8
  - Visiting Researchers (China): 1
  - Faculty support staff: 6
  - Apprentices: 1

- PhD graduates per annum: 2

- Undergraduate Projects and Diploma-/Master Theses per annum: ~80

- Publications per annum: 25-30

- Student Assistants per annum: 50-70

- Certification in 1997 in accordance with DIN EN ISO 9001 in the field of Research and Teaching
### Lectures at the Institute

- Industrial Automation I (German)
- Industrial Automation II (German)
- Software Engineering I (German)
- Software Engineering 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)
- Lab Course Software Engineering
- Lab Course Industrial Automation

### Participation in courses

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

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

Value-added
- Metric-based scheduling

Reliability
- Test management
- Diagnosis

HMI
- Mobile devices
- Context-sensitive assistance systems

Dynamic Coupling
- Retrofit
- Cooperation of heterogeneous systems

Smart Components
- Self-X
- Learning aptitude
- Autonomy

Smart Factory
Smart Home
Vehicle-2-X
Smartphone-based Fault Diagnosis

Requirements:
- Fault diagnosis “for everyone“
- Display of fault diagnosis and repair information in a comprehensible form

Core technologies:
- App programming for smartphones
- Framework to generate apps for the diagnosis of household appliances

Approach
- Diagnosis app to carry out a fault diagnosis by the user
- Digital label to identify the test system
- Framework generates diagnosis apps efficiently
  - Saving diagnosis and repair costs
  - Shortening repair time
Maintenance supported by mobile devices

Requirements:
- Reduction of the complexity of the human-machine interface
- Context-sensitive support for the user

Core technologies:
- Mobile devices (Smartphones, Smart glasses…)
- Knowledge Management System
- Augmented Reality

Approach
Assistance system to support the maintenance process
- Knowledge from heterogeneous sources
- Information consistency
- Multimodal interaction
- Context-sensitive instructions
- Automated documentation

→ Reduction of the complexity of maintenance tasks by improving the human-machine interface
Fault prevention in Industrial Automation Systems

Requirements:
- Detection of imminent faults in industrial automation systems
- Early remedial instructions

Core Technologies:
- Crash-recorder
- Signal monitoring
- Feature identification

Approach
Introduction of abnormality-management
- Saving of measures, which reacts to an identified abnormality
- Systematic identification, evaluation, rectification and prevention (inspection) of fault developments

→ Abnormality-management makes it possible to prevent a fault or an accident or rather to detect fault developments (abnormalities) early.
Test Management

Requirements:
- Support in the selection of suitable test cases
- Automatic prioritization of selected test cases

Core Technologies:
- Multi-Agent Systems (MAS)
- Learning algorithms

Motivation
- Limited time to execute test cases
- Limited time to correct faults detected late

Approach
- Decision support for test managers by agent-based information processing
- Test case prioritization, test resource allocation, fault diagnosis, test script generation, etc.

→ Prioritization of test cases to detect major errors early.
Testing in dynamic production environments

Requirements:
- Ascertain the correct functionality of flexible production facilities

Core Technologies:
- Modelling of dynamic systems
- Test management
- Analytical methods, optimization methods, decision making systems

Motivation
- Fundamental change in testing caused by constant reconfigurations

Approach
- Tailored test initialization
- Automated test coordination
- Using additional information from worldwide networks

→ High test coverage of flexible systems by ensuring the production flow during operation
Cyber Physical Systems for Smart Factory

Requirements:
- Flexible coupling of heterogeneous, industrial automation systems
- Connectivity of the virtual and physical world

Core Technologies:
- Software agents for control
- Application of Internet technologies

Approach
- A variety of scenarios possible:
  - Energy optimization
  - Distributed cooperating production systems
  - Cross-system fault diagnosis and prevention
  - Automated reconfiguration

→ Use of agent technologies allows the retrofitting of existing systems as well as re-planning
**I40-Connector**

Connection of existing systems within the services architecture. This enables the global provisioning of local services.

- existing systems must be integrated
- Services and performance requests must be translated (ontologies)

Connector represents goals and objectives of a subsystem.

- **Goals** (e.g. full utilization of trucks)
- **Intention** (e.g. transport of pallets)
- **Knowledge base** (e.g. distances, loading conditions)
- **Local ontology**

Existing Industrial Automation System

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Dynamic Coupling
Heterogeneous platforms and IT systems must be connected

Easy appending and removing of subsystems

> Automation systems by different manufacturers
> Open architectures
> Proprietary IT system environments

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Realization: Composition
Development and testing in the context of model processes

Preliminary products
- Storage of intermediate products

Storage
- Transport of goods
- Messages about delivery times
- Recognition of the goods

I4.0 Truck
- Order placement
- Monitoring of production
- Visualization of further messages

Individual production
- Assembly of cars
- Automated order management and coordination of the production

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Modell processes at IAS

The model processes are used to represent special automation technology and to demonstrate the capabilities of software systems.
Cooperation with the following companies

- ABB (Asea Brown Boveri AG)
- ads-tec Automation, Daten- und Systemtechnik
- AUDI AG
- BASF SE
- Borries Markier-Systeme GmbH
- Daimler AG
- ETAS GmbH
- iss (Innovative Software Services GmbH)
- KSB AG
- Robert Bosch GmbH
- Siemens AG
- Vector Consulting GmbH
- Vector Informatik GmbH
Objectives of the Institute

- Conformity of teaching and everyday life at the institute
- Practical research-based education
- Acquisition of students
- Technology transfer to small and medium-sized companies
- Cooperation with industrial companies in research projects

Guiding principal of IAS

Practice what is taught, Teach based on research, Apply research results.
Thank you for your interest

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