Research and Teaching at IAS

2017

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 for 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
  - Research Assistants: 5
  - Research staff: 9
  - Visiting researchers (China): 1
  - Faculty support staff: 5
  - Apprentices: 2

- PhD graduates per annum: ~2

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

- Publications per annum: 25-30

- Student Assistants per annum: 50-70
Lectures of 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
The research of Automation Technology is based on applications in the manufacturing industry, automotive and urban life.
Research: Industrial Automation and Software Systems

Value-added
- Metrics & Indicators

Reliability
- Test management
- Diagnosis
- Reliability models

Dynamic coupling
- Cooperation of heterogeneous systems

HMI
- Mobile devices
- Context-sensitive assistance systems

Smart Components
- Self-X and autonomy
- Learning aptitude
- Knowledge processing

Smart Factory
Smart Home
Vehicle-2-X

University of Stuttgart, IAS, Prof. Dr.-Ing. Michael Weyrich
Flexible systems by using Smart Components

Future automation systems are agile i.e. adaptability to the context of use and changing environmental conditions.

- Agent-based engineering of industrial automation systems
- Autonomous automation components and their orchestration
- Modularisation of automation systems
- Realization of fault-tolerant systems
- Realization of innovative applications, e.g. in production
Reliability of Industrial Automation Systems

In addition to functionality, quality features such as reliability, availability and security determine its success nowadays.

- Optimization of reliability and availability
- Determination of the reliability of automation systems in the context of “Internet of Things”
- Adaptive maintenance based on sensor networks and analyzing large amounts of data
- Fault management and automatic reconfiguration
Engineering of (cyber-physical) Industrial Automation Systems
Digital pictures and the networking of information technology changes the Engineering and enables new system functionalities.

- Concepts for verification, validation and testing of automated systems
- Use of mobile devices for information and knowledge processing
- Simplicity and practicality of automation systems
- Distributed development and integration of simulation in the development process
- Integration of heterogeneous system environments e.g. for investment protection
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 for independent fault diagnosis by the user
- Digital label to identify the test system
- Framework generates diagnosis apps efficiently
  - Reduction of repair costs
  - Shortening repair time
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
- Storing 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 means of agent-based information processing
- Test case prioritization, test resource allocation, fault diagnosis, test script generation, etc..
  - Prioritization of test cases for early detection of major errors.
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
I4.0-Connector

Requirements:
- Flexible coupling of heterogeneous, industrial automation systems
- Mapping of different protocols

Core technologies:
- Knowledge-based translation
- Ontologies for knowledge bank

Motivation
- High amount of non-I4.0 compatible automation systems

Approach
- Usage of existing communication interfaces
- Knowledge-based translation of messages
  - The I4.0-Connector allows easy integration of existing industrial automation systems
I4.0-Connector

Connection of existing systems within the service 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.
Dynamic Coupling
Heterogeneous platforms and IT systems must be connected

Use Case: Easy appending and removing of subsystems

- Automation systems of different manufacturers
- Open architectures
- Proprietary IT-system environments

Diagram:
- I4.0-Service-Cloud
- I4.0-Connector
- Production network
- Devices
- Machines
- Plants
- Existing platforms
- Other existing platforms
- Another platform
Realisation: Composition
Development and testing in the context of model processes

- Preliminary products
  - Storage of intermediate products
- Storage
  - Transport of goods
  - Notification of delivery times
  - Recognition of goods
- Individual production
  - Order placement
  - Monitoring of production
  - Visualisation of further messages
- I4.0 Truck
  - Automated order management and coordination of the production
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
- Daimler AG
- ETAS GmbH
- iss (Innovative Software Services GmbH)
- 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 Enterprises (SMEs)
- Cooperation with industrial companies in research projects

Guiding principals of IAS

Practice what is taught, Teach based on research, Apply research results.
Thank you!

Prof. Dr.-Ing. Michael Weyrich

e-mail michael.weyrich@ias.uni-stuttgart.de
web www.ias.uni-stuttgart.de
phone +49 (0) 711 685-67301
fax +49 (0) 711 685-67302

University of Stuttgart
Institut für Automatisierungstechnik und Softwaresysteme
Pfaffenwaldring 47
70550 Stuttgart