



Press Release

Adaptive software architectures for control software to achieve intelligent, evolvable production systems

As manufacturing systems operate for decades and evolve due to physical changes and new market demands, it is not enough to support their efficient initial mechatronic development. Instead, evolution and refactoring of existing automation architectures are essential. Accordingly, the Institute of Automation and Information Systems focuses on the development and evolution of adaptive software architectures for IEC 61131-3 based control software:

- Design of control software including the **object-oriented extension** of IEC 61131-3 to enable **increased flexibility** as a basis for evolvable, resilient production systems.
- In the logistics and process composer, based on the **Application Composer, exemplary solutions are available for intralogistics**, including the connection to the material flow computer, as well as for medium-sized process plants, such as breweries with integrated MES functionality. By storing the modules used in the editor in a library, the later reuse of the model descriptions is made possible, thus the development effort for the control software can be significantly reduced.
- For the **quality assessment of control software**, code analysis and software metrics are used to analyze the architecture and complexity distribution of functions within industrial control software. Company-specific rules can be incorporated in the assessment. The identification and (semi-)automatic resolution of software duplicates (code clones) with **Clone Detection** increases the reusability of the software with reduced maintenance effort.
- **Refactoring of existing control software** in order to (semi-)automatically transfer the historically grown software variants from different projects into a **software product line** with a high degree of reuse.
- 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 in industrial applications and thus optimize production processes. By combining **assistance systems** with formalized, machine-readable process knowledge, engineers during development as well as operators and maintenance staff during the production are supported in a way that is customized to their needs.
- **Benchmarking of control and communication systems** to compare the performance of heterogeneous devices in different dimensions, e.g. speed, utilization, and consistency of timing. The **Automation Server** allows a cloud-based monitoring of such performance indicators.

Only by closely cooperating with machine and plant engineering companies, application-oriented research is enabled. On the one hand, surveys provide deep insights into the current state of software development and the identified optimization potentials. On the other hand, the cooperation allows to ensure the relevance and industrial applicability of the research results. Various solution approaches have been prototypically implemented by the institute and are currently available in industrially applied development tools.

The Institute of Automation and Information Systems (AIS) of the Technical University of Munich addresses the research and implementation of distributed, embedded systems in automation. It focuses on four major research areas: Model-based development, intelligent (cyber-physical) production systems, Big Data in automated production systems and human-machine interaction, with the aim of improving the development, operation, maintenance and re-engineering of hybrid systems. Detailed information on projects and possibilities for cooperation can be found on the institute's homepage.