Berichte aus der Automatisierungstechnik

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Development Process for Distributed Automation Systems based on Elementary Mechatronic Functions

Entwicklungsprozess für verteilte Automatisierungssysteme basierend auf mechatronischen Grundfunktionen

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Summary of Dissertation:

Development Process for Distributed Automation Systems Based on Elementary Mechatronic Functions

(Seno D. Panjaitan)

Market demands, which vary in volume and product type, require highly customized production systems with a low cost and short design cycle. The main challenge for researchers is to develop manufacturing systems that have autonomy and intelligent capabilities of their control components. Additionally, agility and good adaptation of the system to the market change become important aspects. Those requirements affect the control engineering strategy to be able to meet the demands.

Previous generations of industrial automation technology, such as computer integrated manufacturing and programmable logic controller, became much less attractive to comply with the market demands due to the limitation of flexibility. Although some major controller vendors have been providing a solution to face these demands, they may only assure a certain degree of standardization and unification. Some problems can occur when the different manufacturers use controllers and machines from different vendors. Consequently, the software development projects including the maintenance will require a higher cost since the projects have to include the related vendors which will work simultaneously. It is clear to see that the main problem lies in the flexibility and re-configurability of the automation system. Open architecture becomes a feasible solution to convey such capabilities.

Meanwhile, Distributed Automation Systems (DASs) become a preferred option for the control engineering strategy. The DAS is a framework of the agile and flexible automation system, concerning their adaptability to volatile manufacturing environments. A key property of the DAS is the intensive cross-communication and interactions among software components (i.e. entities) and their dynamically changing in the environment. One of the main characteristic of DAS is open architecture, in which functional units are capable of manifesting portability, interoperability, and configurability.

In this dissertation, two requirements on DASs are investigated: (1) flexibility and re-configurability of the control strategy and (2) a comprehensible development process. Three basic approaches are proposed regarding the first requirement. First, an *Operation Modes (OMs)* guideline is proposed to define different control scenarios for distinctive operations. Second, the concept of *Functionality based Control (FBC)* is proposed to improve reusability of the functional software components (i.e. model and source code). Third, the *Scheduler-Selector-Synchronizer (S^3)* architecture is proposed to combine OMs and FBC based on scheduling management. For the second requirement, a development process model for DAS is provided integrating the three proposed approaches in different development phases. The development process considers three work domains, i.e. problem, solution and realization. The guideline of each domain is kept as simple as possible, leading to a better understanding in its adoption. Furthermore, an unambiguous mapping from user requirements into system requirements using relation theory is proposed. UML is used for high-level modeling and IEC 61499 is applied in low-level design and for the implementation in the automation plant.

The practical application of the presented approach is illustrated with the automation process of a Festo didactic Modular Production System (MPS).