Guest Editorial
Information Technology in Automation

INFORMATION technologies play a crucial role in the current and future developments of industrial automation. There are numerous strategic agendas on future manufacturing that have appeared recently worldwide and all of them emphasize the role of information technologies in automation in shaping up the future of production industries. For example, according to the German development agenda Industrie 4.0, the main driving force of the new industrial revolution is the Internet of things (IoT) and Cyber-Physical Systems (CPS).

The IoT concept is becoming a major driver for many industrial applications. In manufacturing, it leads to flattening of the control pyramid, thus, increasing flexibility and enabling unprecedented level of production flexibility and adaptability, making it possible and feasible to produce products in smaller amounts, with shorter time to markets and higher economic efficiency.

In the manufacturing environment, CPS comprise smart machines, storage systems, and production facilities capable of autonomously exchanging information, triggering actions, and controlling each other independently. The research community effort has been focusing on systems interoperability, performance, and efficiency of the design process, as well as assurance in the correctness of systems behavior.

These are just two examples to highlight the importance of information technologies in industrial automation. As it is a rather broad field, the research on this subject has followed many directions. Targets are, for example, making software development more efficient, reducing the system integration effort utilizing IT architecture techniques, or improving flexibility and adaptivity of production systems.

It is our pleasure to present this Special Section on Information Technology in Automation of the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, which reports the state of the art on the subject and new contributions to this field. This Special Section covers a wide range of subjects, namely, the use of knowledge intensive Semantic Web models in process automation engineering, model-driven approaches for engineering data handling, modeling and evaluation of operation procedures, service-oriented flexible system integration frameworks, self-describing CPS components as well as data management and protection in smart cities.

The first paper in this Special Section by Jirkovský *et al.* addresses the challenge of making manufacturing solutions more flexible, thus allowing easy and quick reconfiguration and adaptations to new manufacturing requirements and customer demands and, therefore, meeting the main challenges of the Industry 4.0 paradigm. They describe an approach of pluggable components that possess self-describing capabilities, allowing the automatic integration into an existing system without requiring further integration steps. They showed that such a flexible solution requires not only specific capabilities of the CPS device, but also may need changes of the surrounding system, thus an overall solution design.

Also the second paper by Moutinho *et al.* copes with the problem of component interoperability in distributed automation systems. The paper is based on the Arrowhead Framework, an EU-initiated project for enabling collaborative automation by networked embedded devices. In such a system where many heterogeneous devices should seamlessly work together, they have to come to a common understanding of shared data, at the technological level as well as on the semantic level. As such, the work presents an approach to achieving semantic data interoperability between heterogeneous devices by semantic compatibility verification and generation of translators for XML messages.

Reinforcing the importance of the subject, also the third paper by Xiao *et al.* deals with data exchange issues. Focusing on smart city applications, authors show that a main challenge for achieving cooperative information-sharing ecosystems has become guaranteeing the preservation of data privacy and related security issues. To overcome this issue, they introduce a new architecture for automation systems, the data privacy-preserving automation architecture, which allows the transformation of plain application data to privacy-secure data in real time.

In the following two papers of this Special Section, challenges in engineering of automation systems are addressed. The paper by Engel *et al.* presents an approach for engineering of batch process production systems. Future production systems based on CPS devices, known as Cyber-Physical Production Systems (CPPS), are supposed to provide the flexibility and configurability to cope with frequent changes of products and production requirements. However, the engineering of these systems will become more challenging, requiring innovative engineering methods for reducing engineering effort and time. Therefore, authors propose a novel approach for engineering CPPS. Based on knowledge-based recipe specifications that are backed by ontology models, technical requirements for a plant solution can automatically be derived. Furthermore, the technical requirements are mapped to process modules and networked services to finally derive a custom engineering solution.

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Recently, standards for engineering data have emerged with the goal of allowing engineering data compatibility and tool interoperability at the technical level. The Computer-Aided Engineering Exchange standard (CAEX) has been defined as an XML-based data format for arbitrary hierarchical object information. Based on CAEX, AutomationML has been defined as an open standard for the exchange of plant engineering information, encompassing different technical disciplines along the whole engineering life cycle. Those standards have been adopted eagerly by academia and industry as a basis for model-driven engineering (MDE) approaches. However, besides language standards MDE requires language processing capabilities such as specification editing, visualization, transformation, validation, and others. The paper by Mayerhofer *et al.* presents a MDE workbench for CAEX language processing, which is based on the eclipse modeling framework (EMF), a popular framework for MDE. With a formalization of CAEX in form of an EMF meta model, EMFs rich ecosystem gets immediately usable for CAEX models. Furthermore, the paper shows how CAEX model customization and CAEX language evolution issues are solved using EMF technology.

The final paper of this Special Section then presents a different application using IT in automation. The paper by Rodríguez-Fernández *et al.* presents a framework for modeling and checking operating procedures (OP) for technical processes. Based on Petri Net technology, a specification language for OP workflows is defined. The main objective of the research is then to develop an evaluation method for measuring and analyzing how human operators perform in executing OPs. The method has been evaluated using a case study with an unmanned aircraft system.

Acknowledgment

The Guest Editors would like to thank all the authors who answered the call for this Special Section and all the reviewers who spent their time in reviewing numerous submitted papers, even up to three revisions. In particular, the Guest Editors would like to apologize to those authors whose excellent papers were not included due to limited space and competitive selection process.

Last but not least, special thanks have to be addressed to the managing team of the IEEE Transactions on Industrial Informatics: first, to the Editor in-Chief, Prof. R. C. Luo, who accepted the Special Section proposal. Moreover, warm thanks are extended to L. Jess, the Administrator of the journal, for her excellent support during all the phases leading to the actual publication.

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