Guest Editorial Special Section on the 2018 Conference on Automation Science and Engineering (CASE)

THE 14th Annual IEEE International Conference on Automation Science and Engineering (CASE 2018) sponsored by the IEEE Robotics and Automation Society (RAS) was held on August 20–24, 2018, in Munich, Germany. IEEE CASE is the flagship automation conference of the IEEE RAS and constitutes the primary forum for cross-industry and multidisciplinary research in automation. Its goal was to provide a broad coverage and dissemination of foundational research in automation among researchers, academics, and practitioners. CASE 2018 was organized by General Chairs Birgit Vogel-Heuser and Bengt Lennartson and Program Chairs Cesare Fantuzzi, Alexander Fay, and Georg Frey.

The 2018 edition of the conference took place under the motto "knowledge-based automation," gathering experts from academia and industry to report on recent developments, trends, and research results. In total, 262 papers from 33 countries were presented during the conference. This Special Section in the IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING includes revised and extended versions of eight high-quality papers presented at CASE 2018.

The selection of eight best papers presented in this special section nicely shows the broad scope of CASE, which covers all aspects of automation spanning varying domains from classical ones such as manufacturing and logistics to new ones such as agriculture and renewable energy systems. Also, the dimension of systems covered by automation is shown to vary tremendously from single robots to complete supply chain networks. Furthermore, the section shows that research presented at CASE, as the name Conference on Automation Science and Engineering already implies, ranges from abstract science like ontology building to quite practical engineering like routing algorithms for robots. Finally, it is nice to see that automation often involves multidisciplinary teams.

The first group of articles in this Special Section traverses the wide application areas dealt with at the conference and presents different approaches for the design and optimization of their automated operation.

The Special Section starts with the article "Multirobot routing algorithms for robots operating in vineyards." Thomas C. Thayer, Stavros Vougioukas, Ken Goldberg, and Stefano Carpin, a multidisciplinary team from different departments at the University of California, USA, investigate the use of swarms of robots in vineyards. They show that routing algorithms designed specifically for the application domain outperform general-purpose algorithms. The authors have been awarded with the Best Conference Paper Award at CASE 2018.

Zhen Yang, Li Xia, and Xiaohong Guan, a team of automation and computer scientists from universities in Beijing, Guangzhou, and Xi'an, China, investigate in their article "Fluctuation reduction of wind power and sizing of battery energy storage systems in microgrids" the influence of the intermittency and uncertainty of the renewable energy on the stability of microgrids. Using the sensitivity-based optimization theory, they develop an optimal scheduling policy for the battery storage to cover the fluctuation of wind power in a microgrid. Practical guidance for the type selection and capacity sizing of the battery storage is also presented.

The latter topic is one of the many engineering design problems where continuous and discrete effects are intertwined. In the article "A control approach based on colored hybrid Petri nets and (max, +) algebra: Application to multimodal transportation systems," the authors Karima Outafraout, Ahmed Nait-Sidi-Moh, and El Houcine Chakir El Alaoui from Morocco and France have analyzed such a hybrid dynamical system. The hybrid model allows for a mixed discrete-continuous optimization of (a) passenger waiting times and (b) a number of bus shuttles in case of disturbances.

A multicriteria optimization problem is also addressed in the article "Design of modern supply chain networks using fuzzy bargaining game and data envelopment analysis." The authors Graziana Cavone, Mariagrazia Dotoli, Nicola Epicoco, Davide Morelli, and Carla Seatzu from Italian universities in Bari, L'Aquila, and Cagliari present a method for multistage, multiproduct, multiitem, and closed-loop supply chain network design under uncertainty. The order allocation is based on fuzzy bargaining among the actors to maximize both their own profit and the service level of the network.

Fuzzy inference is applied, too, in the article "A system architecture for CAD-based robotic assembly with sensor-based skills" authored by Yudha Pane, Mathias Hauan Arbo, Erwin Aertbeliën, and Wilm Decré, a joint team from Belgian and Norwegian universities. Suitable robot skills and their parameters are inferred by reasoning on a knowledge base represented as an ontology with semantic models of tasks, skills, and geometric primitives as well as the relations between them.

The second group of articles in this Special Section is devoted to model-based development of distributed and flexible automated systems, with an emphasis on modeling of

Digital Object Identifier 10.1109/TASE.2020.2995956

various kinds of uncertainty, knowledge representation in ontologies, and control of distributed systems with multiagent systems.

The article "Orthogonal uncertainty modeling in the engineering of cyber-physical systems" by Torsten Bandyszak, Marian Daun, Bastian Tenbergen, Patrick Kuhs, Stefanie Wolf, and Thorsten Weyer has been written by researchers from universities in Germany and USA together with Siemens, Germany. It reports about the attempts to account during engineering for unknown situations which a cyber-physical system (CPS), e.g., in industrial production, might encounter during its later operation phase. Modeling uncertainties related to behavioral, functional, and structural properties of a CPS should allow it to collaborate and self-adapt.

Collaborating CPS in a dynamic environment is also the topic of the paper "Ontology building for cyber physical systems—Application in the manufacturing domain." In the cooperation of the authors from university and industry, Constantin Hildebrandt, Aljosha Köcher, Christof Küstner, Carlos-Manuel López-Enríquez, Andreas W. Müller, Birte Caesar, Claas Steffen Gundlach, and Alexander Fay, an engineering method to build ontologies as a suitable technology to enable semantic interoperability has been developed. In addition, reusable ontology design patterns that have been developed with the aforementioned method in an industrial use case are presented.

In the article "Design, application, and evaluation of a multiagent system in the logistics domain," the authors Juliane Fischer, Christian Lieberoth-Leden, Johannes Fottner, and Birgit Vogel-Heuser, all from the Technical University of Munich, Germany, present an agent-based concept for the development of self-configuring material flow systems. This concept refers to a unified system meta-model and thus supports an automatic reconfiguration during runtime in the case of layout changes or failures, as different parts of the material flow system can thus collaborate and jointly perform transportation tasks.

We acknowledge the work of the reviewers, who contributed a lot to the quality of this Special Section by thoroughly evaluating the papers and providing many valuable hints. Furthermore, we thank R. Hytowitz for her continuous administrative support throughout the compilation of this Special Section. Last but not least, we thank the Editor-in-Chief, Prof. M. Y. Wang, for making this Special Section possible.

CESARE FANTUZZI, *Guest Editor*
Department of Sciences and Methods for Engineering
University of Modena and Reggio Emilia
42122 Modena, Italy
e-mail: cesare.fantuzzi@unimore.it

ALEXANDER FAY, *Guest Editor*
Institute of Automation Technology
Helmut Schmidt University
22043 Hamburg, Germany
e-mail: alexander.fay@hsu-hh.de

GEORG FREY, *Guest Editor*
Chair of Automation and Energy Systems
Saarland University
66123 Saarbrücken, Germany
e-mail: georg.frey@aut.uni-saarland.de

BIRGIT VOGEL-HEUSER, *Guest Editor*
Institute of Automation and Information Systems
Technical University of Munich
85748 Garching, Germany
e-mail: vogel-heuser@tum.de