PREFACE

Special section on

Advanced Diagnosis and Fault-Tolerant Control Methods

Faults/failures in technical systems may have many undesired consequences, such as damage to technical parts of plants, endangering of human life or pollution of the environment. Equipment failures may also have profound negative impact on production costs and product quality. The development of fault diagnosis methods allowing early detection of faults/failures is crucial in order to protect complex manufacturing machineries, to increase human life safety, and to support decision making regarding emergency actions and repairs. Moreover, in highly automated industrial systems where maintenance or repair cannot be carried out immediately it is crucial to employ fault-tolerant control systems capable of ensuring acceptable performance even in the presence of faults.

Recent developments and applications of fault diagnosis and fault-tolerant control were presented at the 3rd International Conference on *Control and Fault-Tolerant Systems, SysTol'2016*, held in Barcelona, Spain, on 7–9 September 2016. This special section of the *International Journal of Applied Mathematics and Computer Science* is built around seven selected contributions from this conference, for which the authors were required to propose extended and enhanced versions of their work.

Structural analysis is an important tool in the design of fault diagnosis systems. The paper by S. Pröll, J. Lunze and F. Jarmolowitz shows how structural analysis of fault-detectability can be combined with the design of fault diagnosis systems by means of observers that operate under practical circumstances like disturbances. The main result is the relation between the structurally over-determined part of a linear system that can be obtained by the bipartite structure graph and the structural observability of the system that can be investigated by a directed structure graph.

In many fault diagnosis applications, due to system complexity, no model is available. Then, data-driven methods are a suitable approach. The paper by S. Simani, S. Farsoni and P. Castaldi proposes a data-driven fault diagnosis approach for wind turbines based on fuzzy systems and neural networks used to describe strongly nonlinear relationships between the input-output measurements and given faults.

When designing a fault diagnosis system, the ability of diagnosing the different faults considered is an important feature to be guaranteed during the design process. The paper by B. Li, M. Khlif-Bouassida and A. Toguyéni develops a new approach to diagnosability analysis of discrete-event systems (DESs) modeled by bounded or unbounded labeled Petri nets (LPNs).

A particular application of fault diagnosis is leak localization in water distribution networks. The paper by M. Quiñones-Grueiro, C. Verde, A. Prieto-Moreno and O. Llanes-Santiago introduces an unsupervised approach to leak detection and location in water distribution networks. This approach is based on the zone division of the network, and it only requires data from the normal operation scenarios of the pipe network.

Faults in sensors are a typical problem that control systems have to face. The paper by M. Pazera, M. Buciakowski and M. Witczak proposes a fault-tolerant control scheme based on a strategy for simultaneous estimation of the state and the fault that allows the controller to accommodate the fault.

Fault-tolerant control is a key feature in critical applications such as UAVs. The paper by G.P. Falconí, J. Angelov and F. Holzapfel presents a fault tolerant position tracking controller for a hexarotor system. The proposed controller has a cascaded structure composed of a position and an attitude control loop. The nominal controller is augmented by an adaptive control allocation which compensates for faults and failures within the propulsion system without reconfiguration of the controller.

Finally, the control of complex energy systems requires the use of advanced control strategies. The paper by N. Harrabi, M. Kharrat, A. Aitouche and M. Souissi proposes the use of fuzzy approaches for the control of wind energy conversion systems (WECSs).

We believe that this special section gives a valuable overview of the current results in the fault diagnosis and fault tolerance field, and will encourage the development of enhanced theories and applications. Finally, we would like to thank all the authors and reviewers who contributed to this section.

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Vicenç Puig received the BSc/MSc degree in telecommunications engineering in 1993 and the PhD degree in automatic control, vision, and robotics in 1999, both from Universitat Politécnica de Catalunya (UPC). He is a full professor and the director of the Automatic Control Department and a researcher at the Institute of Robotics, as well as the head of the research group for advanced control systems, all at UPC. He has developed important scientific contributions in the areas of fault diagnosis and fault tolerant control using interval and linear-parameter-varying models with set-based approaches. He has participated in or led more than 20 European and national research projects in the last decade. He has also led many private contracts with several companies, and has published more than 140 journal articles and over 450 papers in international conference/workshop proceedings. He has supervised over 20 PhD theses and more than 40 masterś theses or final projects. He is also currently serving as an associate editor of the *International Journal of Robust and Non-linear Control*, the *International Journal of Applied Mathematics and Computer Science* and *ISA Transactions*. He has also been the vice chair of the IFAC *Safeprocess* TC Committee 6.4 since 2014. He served as the general chair of the 3rd IEEE Conference on *Control and Fault-Tolerant Systems (Systol 2016)* and is currently the IPC chair of IFAC *Safeprocess 2018*.

Dominique Sauter received the *Doctorat des Sciences* degree (1991) from Henri Poincaré University, Nancy 1, France. Since 1993 he has been a full professor at the University of Lorraine, where he teaches automatic control. He was once the head of the Electrical Engineering Department for 4 years and a vice dean of the Faculty of Sciences and Technology. He is a member of the Research Center in Automatic Control of Nancy (CRAN), associated to the French National Center for Scientific Research (CNRS). His current research interests are focused on model-based fault diagnosis and fault tolerant control, with the emphasis on networked control systems and applications to control of energy efficiency in buildings. The results of his research works are published in over 80 articles in journals and book contributions, as well as 200 conference papers. Dr Sauter is currently serving as an associate editor for the *International Journal of Applied Mathematics and Computer Science* and a senior editor for the *Journal of Intelligent & Robotic Systems*. Dr Sauter is a member of the *Safeprocess* Technical Committee of the International Federation of Automatic Control (IFAC). He was appointed by the IEEE Control System Society to the position of the general chair for the organisation of the IEEE Multi Conference on *System and Control 2014 (MSC'14)*, which was held in Antibes (France). He was also the program co-chair of the IEEE *Systol 2016* conference in Barcelona.

Christophe Aubrun received *Doctorat d'Université* in 1993 from Henri Poincaré University, Nancy I, France. Since 2003 he has been a full professor at Université de Lorraine, where he teaches automatic control. He has been the director of Institut Universitaire Professionnalisé (electrical engineering) and the head of the Department of Electrical Engineering of Institut Universitaire de Technologie, Nancy. He is a member of the Research Centre for Automatic Control of Nancy (CRAN). His current research interests are focused on model-based fault diagnosis and fault tolerant control, with the emphasis on networked control systems and continuous commissioning of building energy systems. He has published about 100 refereed journal and conference papers, several book chapters, and one monograph on these topics.

Horst Schulte received the diploma degree in electrical engineering from TU Berlin and the PhD degree in control engineering from Kassel University (Germany). He joined the Bosch Group in 2005, where he worked on R&D projects in the field of modeling, optimization and advanced control. Since November 2009, he has been a full professor at the University of Applied Sciences HTW Berlin. His research interests include nonlinear controller and observer design with Takagi–Sugeno (TS), LPV and sliding-mode techniques, robust control system design, active fault-tolerant control (FTC) system design with industrial applications (e.g., wind turbine control, automotive control, analysis and control of power systems). He was also the program co-chair of the IEEE *Systol 2016* conference in Barcelona.