Guest Editorial: Special Issue on Complex Measurement Systems

Systems engineering encompasses a very wide range of knowledge domains. In any of these areas, complex measurement procedures, applications, and systems must be designed and applied for the advancement in the comprehension of the underlying phenomena and for the optimum control of systems operations. Often, the measurement infrastructure is taken for granted, but great effort is spent by researchers and practitioners to provide valid measurement data, through complex engineering systems. The deployment of a complex measurement system requires proper modeling of the quantities to be measured, of all meaningful influence quantities and their interrelations, suitable design of measurement methods and techniques and validation of results.

Overall, *measurement* is a knowledge-producing process that has wide economic impact. It is estimated that the application and impact of measurement activity is equivalent to 2.7% of the EU gross domestic product and that "for every euro devoted to measurement activity nearly three euros are generated by way of directly estimable benefits alone," "with a benefit-to-cost ratio of nearly 3 : 1" [1].

This is the framework of this special issue, which is focused on the many aspects of complex measuring systems. Seven papers were selected that highlight the various views that can be taken when complex measurement systems are involved. A brief overview of these papers is given as follows.

The usage of existing measurement infrastructure in new ways and the organization of a very wide measurement network is the topic covered by the first paper by Händel *et al.* It describes a complex measurement system based on a global smartphone measurement system, where smartphone owners are the actual measurement probes. The measurement model includes seven levels, going from the physical one to the more abstract business model level. An interesting application of this measurement framework is presented, by which the road traffic situation in the Greater Stockholm area is monitored through the involvement of people driving their cars.

With no doubt, the topics of location-based services and indoor and mobile positioning have been the subject of many research activities because of an increase demand for these services and of the application scenarios they would open. Clearly, complex measurement systems are involved in the provision of these services. These topics are covered in the second paper of this special issue by Liu *et al.*, where the focus is put on the subject of mobile positioning. This is intended as the ability to determine one's position by the usage of dead reckoning, inertial navigation methods, or vision-based systems. This paper provides an overview of mobile positioning and illustrates the current state of the art in this areas through the performance comparison of several recently proposed architectures and measurement methods.

The following two papers deal with the goal of fault detection and location. The paper by Reddy *et al.* proposes a measurement technique based on the joint usage of wavelets and computational intelligence, to detect transient current signals as symptoms of abrupt changes of current in the smart grid. The complexity here refers both to the structure of the electric power system network and in the procedure devised to measure signal features and decide on the possible occurrence of a fault.

The paper by Eftekhari *et al.* deals with the detection of short-circuit faults in induction motor's stator windings. Any measurement system requires a modeling phase, in which systems are analyzed and it is decided which parameters must be included in the model and how the information is treated, to provide the knowledge required to reach the measurement goal. Here, the goal is to provide a measurement setup capable to detect incipient turn-to-turn short circuits in stator winding of three-phase inductive motors, to possibly avoid severe damages to stator windings and stator core. The technique is based on the analysis of three-phase current locus in 3-D space and the modifications appearing in that space when faults occur. Experimental results complete the validation of the measurement system.

The following paper by Chahal *et al.* deals with the issue of measuring space charge in insulating materials, which is considered to be responsible for the degradation of the material properties. The proposed measurement procedure is based on a pulsed electroacoustic method, whose properties are analyzed, in depth, by means of both suitable models of the phenomena, allowing transmission of the electroacoustic waves and usage of a suitable circuital simulator. Experimental data validate the measurement approach.

Two other papers on reliability by Murhty *et al.* conclude this special issue. The topic of the first paper is related to the reliability of phase measurement units (PMU). These are the building blocks of wide-area measurement systems used for measuring the state of a power distribution network. Thus, measurement and determination of the reliability of PMUs has become significant to improve operations in smart grids. Hidden Markov models are used in this paper to provide a

Digital Object Identifier 10.1109/JSYST.2014.2365911

technique for the estimation of the reliability and availability of PMUs, and a case study is presented in detail to show the applicability of the devised procedure.

The last paper covers the same topic of PMU reliability but from a different perspective. Since reliability data on PMUs are scarce, alternative models must be applied to determine dependability properties of these systems that are suitable under these constraints. The authors proposed the usage of fuzzy logic to address this problem and to provide information for concurrent estimation of reliability uncertainties.

Finally, I wish to thank all people that made this issue possible: the Editor-in-Chief, Prof. Vincenzo Piuri, the members of the editorial staff of the IEEE Systems Journal, the anonymous reviewers, and all authors who submitted their original work to this special issue.

PAOLO CARBONE, *Guest Editor*

REFERENCES

[1] G. Williams, "The assessment of the economic role of measurements and testing in modern society," Univ. Oxford, Oxford, U.K., 2002, Final report of the GROWTH Project.

Paolo Carbone (M'94–SM'09) received the "laurea" and Ph.D. degrees from the University of Padova, Padova, Italy, in 1990 and 1994, respectively.

From 1994 to 1997, he was a Researcher with the Third University of Rome, Rome, Italy. From 1997 to 2002, he was a Researcher with the University of Perugia, Perugia, Italy. Since 2002, he has been a Full Professor with the University of Perugia, where he teaches courses in instrumentation and measurement and in reliability and quality engineering. He has been involved in various research projects, sponsored by private and public funds. He authored/coauthored more than 150 papers and appeared in international journals and conference proceedings. His research objective is to develop knowledge, models, and systems for the advancement of instrumentation and measurement technology.

Dr. Carbone served as an Associate Editor for the IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—PART II, from 2000 to 2002, and the IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—PART I, from 2005 to 2007. He was the Chairman of the International Measurement Confederation (IMEKO) International Workshop on ADC Modeling and Testing, in 2003 and 2011, and the IEEE Nordic-Mediterranean Workshop on Time-to-Digital Converters, in 2013.