Advances in Sensors and Measurements for Metrological Applications

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Received: 02 June 2021 / Accepted: 05 June 2021 / Published online: 19 July 2021

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Abstract: The preface discusses the summary of the special issue consisting of 24 peer-reviewed papers on the theme Advances in Sensors and Measurements for Metrological Applications. These papers discuss the state-of-the-art reviews by highlighting various technological innovations, processes developed pertaining to the design, development as well as characterization of sensors, their measurement methods/strategies at different National Metrology Institutes (NMIs) and academic/research institutes across the globe. Different methodologies adopted for designing the sensors and development of measurement methods have been presented by various researchers. These shall be instrumental in strengthening the traceability chain, fostering the industrial development and Industry 4.0 in national and international scenario.

Keywords: Sensors; Advanced materials; Metrology; Calibration; Uncertainty evaluation; Testing; Traceability; Industry 4.0; Digital MEMS; White Rabbit (WR) network

1. Introduction

The role of sensors in metrological applications is most significant as they collect the data to drive a particular application. Sensors are electrical, opto-electrical, mechanical or electronic devices with integrated electronics or otherwise sensitive materials for determining the presence of a particular entity or function. They have wider applications not only in industry, but also in environment, health, safety, defense and space research. Basically, sensors detect some physical quantities like temperature, pressure, humidity, the presence of light and convert it into analog or digital format which in turn is read by the microcontroller for further processing and storage. They play a pivotal role in environment and meteorological applications, enabling smart decisions, prediction of future conditions, etc. The use of digital sensors in engineering applications and monitoring systems is widely enhanced since the last decade, in the context of smart manufacturing, Industry 4.0, Internet of Things (IoT) sensors networking, as well as in environmental and infrastructural monitoring. Thus, the major challenges faced by industry and academia is the design and development of accurate

and precise, low-power consuming and low-cost sensors. These sensors maintain high quality in the control processes monitoring or measurements and flexible in providing enhanced data collection, automation and operations. The digitalization of the manufacturing and industrial processes have advocated the need of MEMS sensors. However, the lack of metrological traceability is a major hurdle faced. Thus, innovative measurement methods and strategies have to be designed and developed for metrological characterization of the sensors for enhanced accuracy and precision in the measurements traceable to the national and international standards. It is thus imperative that technological innovations pertaining to the development of smart sensors and measurement methods and strategies for metrological applications shall be instrumental in strengthening the traceability chain and shall foster the Industry 4.0 and augment the economic growth of any country.

2. Summary

The first/feature article is authored by Anshul Varshney et al. of CSIR-NPL, India. This article addressed the challenges in sensors technology for industry 4.0 for futuristic metrological applications. This study focused on the role of smart sensors and IoT-enabled industrial

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infrastructure for adapting to the advanced technologies based on fusion of smart sensors.

The second article is authored by Aakanksha Avnish Bhardwajan et al. of ISRO, Bangalore, India. This study focused on navigation with Indian Constellation and its applications in metrology. The designed Indian Regional Navigation Satellite System (IRNSS) provides accurate position information in the Indian sub continent.

The third article is authored by Harish Kumar Rathore et al. of CSIR-NPL, India. This article described the design and development of a universal device for precise and accurate distribution of time or frequency signal.

The fourth article is authored by Neeru Rathee et al. of Maharaja Surajmal Institute of Technology, New Delhi, India. This study focused on evaluating the uncertainty of classification due to image resizing techniques for satellite image classification.

The fifth article is authored by Neelam Yadav et al. of CSIR-NPL, India. This study focused on establishment of an optical fiber link for precise time and frequency transfer utilizing White Rabbit (WR) network.

The sixth article is authored by Wang Jintao et al. of National Metrology Institute (NIM), China. This study focused on design of a fully automatic hydrometer calibration system in NIM using the Cuckow method.

The seventh article is authored by A. Rascón-Careaga et al. of Universidad de Sonora, Mexico. This study focused on validation and evaluation of uncertainty for a glucose determination method GOD-PAP using a multi-calibrator as reference.

The eighth article is authored by Rab Shanay et al. of CSIR-NPL, India. In this article various configurations of kinematics support on the different materials such as granite and stainless-steel plates have been studied and analyzed.

The ninth article is authored by Rahul Kumar et al. of CSIR-NPL, India. This study focused on a design and development of a temperature-compensated body mass index measuring system.

The tenth article is authored by Raman Sharma et al. of CSIR-NPL, India. This study focused on design and development of an indigenous cross-floating pressure calibration system up to 140 MPa. This newly developed system will help the customers in providing in-house traceability to their own instruments as well services to the industries.

The eleventh article is authored by Kumar Vinay of Jubail Industrial college, Saudi Arabia. This study analyses another pressure sensing application of relaxor materials among many other applications.

The twelfth article is authored by Rajeev Dwivedi et al. of CSIR-NPL, India. The focus of the study is to evaluate the percentage error in the measurement of length, distance and angle using the novel pixel counting technique (PCT).

The thirteenth article is authored by Kalpana Yadav et al. of CSIR-NPL, India. This study focused on a comparative study of the dimensional measurements of an ASTM reference block is carried out using ultrasonic contact and immersion methods.

The fourteenth article is authored by Zafer Afaqul et al. of CSIR-NPL, India. This study focused on feasible methods for g-measurement and uncertainty comparison with Monte Carlo Simulation method.

The fifteenth article is authored by Bushra Ehtesham et al. of CSIR-NPL, India. This study focused on the limitations of an artifact-based definition and the significance of the redefinition and its implications.

The sixteenth article is authored by Pati Santwana et al. of CSIR-NPL, India. This study focused on a pilot study on the comparison of the methods for uncertainty analysis of micropipette calibration.

The seventeenth article is authored by Priyanka Jain et al. of CSIR-NPL, India. This study focused on determination of inductance through capacitance using commercial LCR meters.

The eighteenth is authored by Aman Dahiya et al. of Maharaja Surajmal Institute of Technology, New Delhi, India. This study focused on design and construction of a low loss substrate integrated waveguide for S band and C band applications.

The nineteenth article is authored by Hatefi Shahrokh et al. of Nelson Mandela University. This study focused on the design of electro-optical vibrometer for on-machine metrology in hybrid single-point diamond turning.

The twentieth article is authored by Sudesh Pahal et al. of Maharaja Surajmal Institute of Technology, New Delhi, India. This study focused on evaluating uncertainty of measurement while predicting location in smart vehicles.

The twenty first article is authored by Anju Rani et al. of Indian Institute of Technology Ropar, Rupnagar, Punjab, India. This study focused on frequency modulated thermal wave imaging for infrared non-destructive testing of mild steel.

The twenty second article is authored by Sharma Chhemendra et al. of CSIRNPL, India. This study focused on a case study on Indoor Air Pollution in Indian Rural Kitchen.

The twenty third article is authored by Harshwardhan Choudhary et al. of National Institute of Technology Delhi, India. This study focused on a review on additive manufactured sensors.

The twenty fourth article is authored by Sahiba Bano et al. of CSIR-NPL, India. This article focussed the attention on accurate and precise measurement of Seebeck coefficient that includes various sources of errors from contact geometry, sensors, measurement techniques and thermocouple.

Acknowledgements Editorial team is thankful to Director, CSIR-National Physical Laboratory, New Delhi and Director, Maharaja Surajmal Institute of Technology (MSIT), Delhi for their kind cooperation for successful organization of 7th National Conference on Advances in Metrology (AdMet-2021) at MSIT, Delhi. The issue has been an outcome of the most of the selected extended papers presented in this conference. Editorial team is also extremely thankful to Dr. Yogendra Arya, Faculty, MSIT, Delhi for his immense contributions and support to this special issue.

published more than 90 research papers in journals and International conferences. He has also registered 7 patents to his credit and out of which six technologies have been transferred as consultancy projects. He has also been instrumental providing his technical expertise to the Indian industries as well as SAARC nations. He is a fellow of many professional national and international societies. He was working as Chief Scientist and Head at NPL before joining as Director at Maharaja Surajmal Institute of Technology, Janakpuri, New Delhi.

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