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Editorial to selected papers from the 2023 IMEKO TC8 & TC11 & TC24 Joint Conference

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Dear Readers,

This Special Issue collects the extended version of some of the contributions presented at the 2023 IMEKO TC8 & TC11 & TC24 Joint Conference, held in Funchal (Portugal) from the 11th to the 13th of October 2023. This international conference gathered experts both from industry and academia, covering different topics from the field of 'Traceability in Metrology' (IMEKO TC8), 'Measurement in Testing, Inspection and Certification' (IMEKO TC11), and 'Chemical Measurements' (IMEKO TC24). Considering the wide interdisciplinarity of the three Technical Committees, many topics and metrological issues were addressed by the Conference participants. In the following, the published papers will be individually presented.

The paper 'Calibration methods for high frequencies: development and validation' by M. Cundeva-Blajer et al. [1] presents an introduction of an advanced method for calibration of high-frequency instruments, such as oscilloscopes, frequency counters and function generators that operate at frequencies from 1 MHz to the GHz range. Based on conducted thorough survey of the needs for calibration of high-frequency measurement devices in the region of Southeast Europe, and the identified calibration and measurement capability gap in comparison to the international metrology offer, the Laboratory for Electrical Measurements at Ss. Cyril and Methodius University in Skopje developed new methods, following the general recommendations of the EURAMET cg-7 Calibration Guide. An original approach in the design of the experimental procedure, and a novel data fusion concept for the evaluation of the measurement uncertainty is deployed. The paper also investigates and resolves some challenges of setting up an unbroken measurement traceability chain, and uncertainty estimation for calibration in the domain of high frequencies.

In the paper "Improvement of metrology infrastructure in the area of extreme impedance calibrations" the authors M. Cundeva-Blajer et al. [2], report on how the Laboratory for Electrical Measurements at the Ss. Cyril and Methodius University in Skopje, an accredited calibration laboratory, enhanced its calibration and measurement capabilities for extreme values of electrical impedance. This was conducted through development of new calibration methods for instruments that measure very high electrical resistance and inductance. The paper also explains how these methods were validated to ensure traceability and how the measurement uncertainty in impedance instruments calibration was innovatively estimated, by deploying the data fusion concept to increase the metrology infrastructure capacity.

The contribution "Measurement uncertainty evaluation of equivalent roughness in hydraulic pipes" by L. Martins et. al. [3], addresses the quantification of the dispersion of equivalent roughness values obtained from the experimental study of hydraulic pipes used, for example, in water supply networks. This quantity is mainly used in the determination of the friction factor related to pipe fluid flow. In this context, non-linear and complex mathematical models, such as the Colebrook-White equation, are applied to characterize the equivalent roughness of hydraulic pipes composed of different types of materials. The paper describes the application of a Monte Carlo method in the measurement uncertainty evaluation of equivalent roughness. In addition to presenting the theoretical and experimental background, the paper describes the measurement uncertainty propagation, from the probabilistic formulation of the input quantities up to the output quantity. A numerical example, based on experimental data retrieved from field testing of hydraulic pipes integrated in a large-scale agricultural irrigation network, is

shown in the paper, illustrating the suitability, advantages, and limitations of the proposed approach.

A methodology for obtaining digital machine-readable measurements from numerical displays images is given in the paper "Automating flowmeter calibration process: digital measurements from numerical displays using open-source optical character recognition tools", by the authors G. Esteves Coelho et. al. [4]. The proposed method provides means to digitalize and automate a previously manual and labour-intensive laboratory procedure for flowmeters calibration. The proposed method allows the user to obtain machine-readable readings from remote numerical displays with available-off-the-shelf hardware and open-source software. By using smartphones for remote image capture and streaming and the Tesseract open-source OCR engine, it is possible to leverage the infrastructure's digital transition, improve procedures efficiency and effectiveness while promoting sustainable actions with cost reductions.

The study "Traceability and measurement uncertainty of non-removable field flowmeters using clamp-on ultrasonic flowmeters as reference", by C. Simões et. al. [5], examines the traceability and measurement uncertainty of in-situ hydraulic calibration of flowmeters using clamp-on ultrasonic flowmeters as reference. The procedure compares the equipment readings with the reference ones. Measurement uncertainty evaluation uses Guide to the expression of Uncertainty in Measurement (GUM) formulation, considering the linearity conditions of the mathematical models applied. Experimental values are used to test the procedure and its suitability for actual cases where the expected accuracy needs to be achieved.

In the paper 'Overcoming traceability challenge in air quality measurements by developing reference gas mixtures of CO2 in a typical indoor/outdoor range for future relevant IoT technology applications' by N. H. AlYami and co-Authors [6], an important issue for air-quality monitoring is addressed. Reference gas mixtures are prepared to calibrate gas sensors and keep traceability to SI units in IoT applications. An approach for evaluating measurement uncertainty and validating the proposed gas mixture preparation methodology is presented.

We hope you will enjoy your reading.

Marija Cundeva-Blajer,
Leonardo Iannucci,
Thomas Wiedenhöfer

Section Editors

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