

Editorial for selected papers from the Acta IMEKO Thematic Issue on the XXX Italian National Congress on Mechanical and Thermal Measurements

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Dear Readers,

Since scientific knowledge and technological advancements are fundamentally rooted in the evaluation of physical quantities, it is unsurprising that research activities focused on measurement methods and systems, as well as the culture of measurements, are of significant interest, fruitfulness and importance to the scientific and technical community.

Among the key research areas, Mechanical and Thermal Measurements stand out as a distinct field of science with a broad spectrum of applications: from the design and development of sensors to the characterization of measurement methods and systems, signal processing, and the management and quality assessment of measurement data. Moreover, this field encompasses environmental monitoring, on-line inspections of mechanical components and instrumentation for medicine and biology.

The miscellany and specificity of these aspects are actively debated at the annual Italian meeting of the “Forum Nazionale delle Misure”, where new ideas and trends in measurement science and technology are proposed and discussed during continuous and fruitful exchanges between younger and long experienced researchers.

In September 2023 the Forum was organized as in-person meeting and took place in Bologna, Italy. As is customary, the workshop included joint meetings between scientists from the Mechanical and Thermal Measurement and the Electrical and Electronic Measurement academic groups. These sessions fostered inspiring discussions and feedback on shared topics, enriched by the diverse viewpoints and cultural backgrounds of the participants. Additionally, more specific topics were addressed in separate sessions, allowing for in-depth debates within each group.

This special issue features a selection of four papers presented during the three-day “Forum”. The authors were invited to review their work and prepare extended versions suitable for publication in Acta IMEKO.

The diversity of the topics covered in these selected works is a clear and rigorous example of the cultural richness and interdisciplinary nature of the Mechanical and Thermal Measurements field, providing numerous and interesting insights for readers.

In recent years, the coastal waters of the Mediterranean Sea have faced increasing pollution from aromatic hydrocarbons. This alarming trend needs the implementation of robust damage minimization actions, including continuous monitoring systems with rapid response capabilities. With this aim the paper ‘*Low cost UV-induced fluorescence sensor for monitoring aromatic hydrocarbons in coastal marine water*’, F. Lo Savio et al [1] deal with the design and development of an innovative UV-induced fluorescence sensor, which is mounted on a sensor-buoy and in coastal waters can detect pollutants from aromatic hydrocarbons under any atmospheric condition.

The device includes a measuring chamber, where water maintains a constant level via a small siphon. The detection system, comprising a UVC-LED and a phototransistor responsive in the visible light band, is strategically positioned in the chamber’s upper part. In vitro tests comparing the sensor’s results with those from a spectrofluorometer have demonstrated its good sensitivity, repeatability, and accuracy, despite its low cost and energy consumption. Moreover the sensor’s design ensures it can withstand harsh weather conditions, the corrosive action of salt water and biofouling.

In addition to pollution monitoring, sea state information is crucial for coastal engineering and navigation safety. Inertial Measurement Units (IMUs) have proven effective in real-time

sea state estimation and, in this regard the paper ‘Wave Heave Sensor Verification in Dry Conditions with Optoelectronic Reference’ by Mohamad Khalil et al. [2] highlights a novel method for verifying heave inertial sensors in a dry environment. The distinctive aspect of this approach is that the IMU movement is measured by an optoelectronic external instrument, rather than relying on the mechanical assembly of the movement generation device. This method has been tested with a general-purpose IMU, requiring specific processing procedures to measure heave. Different approaches were proposed and compared, enabling a quantitative evaluation of the heave measurement by inertial sensors, including measurement uncertainty under various test conditions.

Beyond IMU applications, image analysis-based measurement techniques are also gaining interest and popularity due to their non-intrusive nature. Thermoelastic Stress Analysis (TSA) is a full-field, non-contact technique that uses IR images and the principle of thermoelasticity to measure stress distributions. In this regard G. Tribbiani et al. [3] presented a paper entitled ‘Exploring The Operational Limits of a Bolometric Camera for Thermoelastic Stress Measurements Using a Photonic Reference Camera’, dealing with the potential of using bolometric thermal cameras instead of photonic sensors to reduce instrumentation costs. The study involved tuning the acquisition parameters of a bolometric thermal camera and setting the appropriate excitation frequency to match the stress measurements obtained using a reference photonic thermal camera. The results indicated that more frames provided detailed stress distribution maps and reduced the measurement gap between the two IR systems.

A further image analysis-based measurement method is proposed in the study ‘Experimental and Finite Element Analysis Approach for torque assessment in CSFH-based microgrippers with different geometries’, written by the research unit of the University of Roma Tre, led by Prof. S.A. Sciuto [4], with the aim to evaluate the dynamic characteristics of microgrippers with capacitive actuators. Microgrippers, which are MEMS devices capable of precise manipulation on a micrometric scale, have been evaluated using a novel approach that combines experimental measurements based on image analysis with finite element analysis. The study focused on microgrippers with electrostatic rotary comb-drives and conjugated surface flexure hinges. Experimental results confirmed the effectiveness of this

approach in assessing the torque output of microgrippers’ actuators. The findings reported a quadratic trend for torque as a function of the supply voltage and validated the numerical model, enabling the implementation of a phy-digital twin for simulating microgripper behaviour under various conditions.

We extend our heartfelt gratitude to all the Authors who contributed to this special issue, as well as to the Reviewers for their invaluable input. Special thanks are due to Prof. Francesco Lamona, Editor in Chief of ACTA IMEKO, for his enthusiastic and precious support in making this special issue possible.

We are honoured to have played a role in the growth of our national research group through this special issue and eagerly anticipate broader and more distinguished participation in future editions of our Forum.

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Guest Editors

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