

# Introductory notes for the Acta IMEKO thematic issue on the XXXII Italian National Congress on Mechanical and Thermal Measurements – part I

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Dear Readers,

Scientific and technological progress is deeply intertwined with the accurate evaluation of physical quantities, making the field of measurement science essential and highly valued within the research community. In particular, Mechanical and Thermal Measurements are a specialized discipline, encompassing applications such as sensor design, system characterization, signal processing and data quality management. This field is also relevant in areas like environmental monitoring, inspection of mechanical components and biomedical instrumentation.

These different applications are regularly examined and discussed during the annual Italian event, the "Forum Nazionale delle Misure," where both emerging and established researchers share ideas, innovations and trends in measurement science and technology. The 2024 edition of the Forum was held in San Vincenzo, Italy, as an in-person event. As usual, it featured joint sessions between researchers from both the academic groups of Mechanical and Thermal Measurements (GMMT), and Electrical and Electronic Measurement (GMEE), where rich exchanges of ideas are provided thanks to different perspectives and backgrounds. Additional specialized sessions allowed for more focused technical discussions.

This thematic issue is the first volume of a collection showcasing selected papers presented during the Forum (further articles of the Forum will be proposed in a next issue of this journal): authors were invited to revise and expand their work for publication in Acta IMEKO. The selected contributions exemplify the interdisciplinary richness and cultural depth of the Mechanical and Thermal Measurements field, providing valuable insights for the readership.

In hostile environments the performance of optical systems is likely to be compromised by the presence of external contaminants. This relevant issue is the focus of the paper "*Assessing the effectiveness of sharpness metrics to determine the presence of contamination on thermographic cameras in harsh environments*" by V. Medici et al. [1], where image sharpness metrics are investigated as indicators of contamination on thermographic camera lenses in industrial environments. In particular some tests have been carried out in laboratory, where the optical window of a thermal imaging camera was contaminated by adding small amounts of dust at a time. After that, a series of images were collected for each amount of dirt and different algorithms were applied to obtain sharpness indices. Among evaluated metrics, Histogram Entropy, Range and Brenner algorithm showed strong sensitivity and low uncertainty. Furthermore, the above algorithms have been combined to improve the accuracy of the diagnostic tool and validated using data from a real industrial scenario: the combined metric achieved high diagnostic accuracy ( $R^2 = 0.96$ ), supporting its use in contamination monitoring.

The application of thermographic cameras in an industrial scenario is the topic of the preliminary study entitled "*Uncertainty analysis in the estimation of construction and demolition wastes emissivity through infrared thermography*" written by G. Salerno et al. [2], where a procedure is presented to support the classification of several construction and demolition waste materials, by estimating their emissivity through active infrared thermography. An uncertainty analysis via Monte Carlo simulation highlights that measurement uncertainty propagates through the chain, especially affecting materials like plastics, where output uncertainty is more than doubled. More accurate results can be achieved analysing a higher number of specimens per class and combining active thermography with other non-contact sensors.

Use of optical systems in industrial environments may require a SNR optimization, as in the case of geometry measurements of incandescent steel objects. In this regard Pasquinelli et al. presented a paper entitled “*Laser line triangulation measurement on incandescent steel objects: methodologies to improve optical signal to noise ratio*” [3] dealing with the challenges of using Laser Line Triangulation (LLT) in environments where steel reaches temperatures over 1000 °C. A narrowband optical filter improves signal-to-noise ratio but introduces detection loss. A software workaround using ROI-based image processing and positioning via robotics significantly enhances line detection accuracy.

A further application of non-contact sensing and image analysis is also the focus of the work proposed by A. Annessi et al, entitled “*Shoot architectural analysis for olive cultivar characterization: an automatic internode measurement procedure*” [4]: in the paper a method using 3D photogrammetry and the open-source TreeQSM tool is developed to automate the measurement of olive tree shoot architecture. The system calculates internodal distances and node diameters, offering precise data useful for agronomic practices, such as selecting cultivars for high-density planting. Results show consistent average measurements with manageable variability.

Optical systems can be used successfully in peculiar biomedical scenarios, like the measurement of start and end times of hand-wheel contact during wheelchair propulsion: this is the topic of the study “*Comparing marker-less vision systems for contact detection in wheelchair propulsion: Evaluating the limitations of angular speed difference*” by E. Ferlinghetti et al [5], dealing with the comparison between two systems for identifying hand contact during wheelchair propulsion—ASD (angular speed difference) and MLVS (multi-layer vision system). ASD, relying solely on motion data, produced less accurate results (~155 ms RMSE), while MLVS, combining depth and positional data, achieved better accuracy (~60–90 ms RMSE), proving more reliable for contact detection. The work conclusions highlight that the relative angular speed between hand and hand-rim cannot be used as a reliable predictor of contact within the assessed experimental setup.

We sincerely thank all the Authors who made contributions to this special issue, and we deeply appreciate the insightful feedback provided by the Reviewers. We also wish to express our

special gratitude to Prof. Francesco Lamonaca, Editor in Chief of ACTA IMEKO, for his enthusiastic support and invaluable help in bringing this issue to fruition.

It has been a privilege to contribute to the advancement of our national research community through this initiative, and we look forward to even wider and more prestigious involvement in the upcoming editions of our Forum.

We hope you will enjoy your reading.

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Section Editors

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