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Introductory notes for the Acta IMEKO fourth issue in 2024

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Dear Readers,

The end of the year is coming and as Editor in Chief of Acta IMEKO it is my pleasure and duty to thank all of you for your support to the journal as Readers, Authors, Reviewers, and Editorial Board Members. Thanks to you, Acta IMEKO is further improving its reputation. Indeed, Acta IMEKO is now indexed by Web of Science, Scopus and DOAJ (Directory of Open Access Journals) and according to SJR ranking, for the first time, the Journal is stable in the third quartile in the field of Instrumentation, Electrical and Electronic Engineering, and Mechanical Engineering.

In recognition of their outstanding service as a Reviewers, this year the Best Reviewer Award goes, ex-equo, to Raffaella De Marco and Gabriele Bocchetta. It is also my pleasure to announce the names of the Top Reviewers in 2024:

- Carmelo Scuro
- Giorgia Fiori
- Yousif Alaraji
- Beatrice Calosso
- Cipriano Bartoletti
- Flavia Bartoli
- Ilaria Carlomagno
- Domenico Luca Carnì
- Kruno Milicevic
- Luca James Senatore.

This Acta IMEKO issue comes with the Special Issue including extended selected papers of the *2023 IMEKO TC4 International Conference*, section editors Jakub Svatos, Luca Callegaro, Jan Saliga, and Platon Sovilj, the Special Issue including extended selected papers of the *2023 IMEKO TC17 International Symposium on Measurement and Control in Robotics*, section editor Zafar Taqvi and the Thematic Issue including extended selected papers of the *XXX Italian National Congress on Mechanical and Thermal Measurements*, section editors Alfredo Cigada, Roberto Montanini, Francescoantonio Lucà, Antonino Quattrocchi, Andrea Scorza.

As usual, also this issue includes a General Track aimed to collect contributions that do not relate to a specific event. As Editor in Chief, it is my pleasure to give you an overview of these papers, with the aim of encouraging potential authors to consider sharing their research through Acta IMEKO.

Archaeology is the discipline that studies past human civilizations by collecting, documenting and analysing the traces left by the ancestors. The cross-contamination of different scientific fields such as geology, chemistry and physics endorsed a more accurate analysis of the archaeological sites. The work in [1] analysed samples from the archaeological site of Orgères, located near La Thuile (Valle d'Aosta) through the following methodologies: ICP-OES (Inductively Coupled Plasma-Optical Emission Spectroscopy), and CHNS analyser. Inside the site, artefacts from the Roman era and structures from the 17th century were found. Results of four different areas were compared with samples taken outside the site. The main soil constituents were analysed through principal component analysis that allowed an in-depth study of the relationships between the samples and highlighted the variables that most influenced the observed relationships. By evaluating the data set, it has been possible to date the site and the activities that were carried out at the archaeological site.

Plants remains and phytoiconographic elements are important tools to reconstruct the lost gardens. Archaeobotanical data can give controversial results in areas having great anthropic disturbance, such as in the suburban *Villa della Piscina in Centocelle* (Rome). Thus, the authors in [2] analysed the plant representations to provide information for the reconstruction of the ancient gardens, studying the fragments of the decorated wall and of the ceiling structures remains that are usually neglected in their size, shape and colour. After the identification of the plant species, the Authors collected

information on their symbolic value and on their role in the garden. Preliminary data showed the presence of about twenty species, mainly from the Mediterranean area. The symbolic groups presented a slight prevalence of solar and salvific elements. For the garden, the Authors identified species used to decorate and border the flowerbeds, but also with productive role. The analysis of these represented naturalistic elements gives support in understanding the historical greenery behind their representation.

The work in [3] reports the results of a study focused on the characterization of the material alterations in archaeological discoveries. The proposed approach is based on the thermographic analysis of the thermal response of the different parts affected by degradation or alterations such as alveolisation process, erosion, damages, and deposition of iron oxide. Material alterations are characterized by changes of emissivity. Consequently, thermographic images show significant differences in the temperature values even if the object is in thermal equilibrium. This apparent temperature variation can be characterized and compensated by evaluating the emissivity of each part having material alteration. Material alterations are not always visible at naked eye and are even responsible for changes of the dynamic thermal response when external thermal solicitations happen. The erroneous interpretation of such features is inevitably cause of an incorrect analysis of data with consequent altered results. The paper in [3] focuses on this issue to advise operators to pay attention to such aspects. The proposed case study is a marble bust of a woman that dates back to ancient Rome. The results show the need to characterize the presence of material alterations by analysing the thermal response in static and dynamic conditions. Recommendations are provided to compensate the thermal changes in thermographic images by assessing emissivity variations.

In [4] a doctoral research project results are presented, that have led to a greater understanding of the settlement dynamics that took place in the Mignone Valley over the long chronological period between the 6th and 11th centuries AD. This understanding has been achieved through the recent topographical investigations conducted in the context of the Mignone Valley. The research employed the ancient land uses, the road system and the exploitation of the rich mineral deposits of the 'Monti della Tolfa' as 'keys' for understanding the change, employing a statistical analysis method for the evaluation of the input data on which the overall assessment of the settlement dynamics in the area was based. The contribution that is presented in [4] it is intended to analyse the type of statistical method that underlies the evaluation of the data collected and the preliminary achieved results through the realisation of particular spatial analyses calculated in a GIS environment on the data to which the logic-statistical process has attributed the greatest 'weight'.

Bioelectrical Impedance Analysis (BIA) is a simple, non-invasive, real-time diagnostic technique routinely used in human clinical practice to assess body composition and hydration status. BIA raw parameters, particularly the Phase Angle (PhA), are gaining attention as markers of congestive states in humans, as body electrical impedance can be affected by variations in body water content. The study in [5] aims to assess whether changes in BIA raw parameters in dogs with myxomatous mitral valve disease (MMVD) could be linked to disease progression. Nine Cavalier King Charles Spaniels (CKCS) with MMVD were prospectively recruited in a longitudinal study design. During the clinical follow-up of each dog, BIA raw parameters - Impedance (Z), Resistance (R), Reactance (Xc), and PhA - were recorded alongside NT-proBNP assessments at two time points. A reduction in PhA recorded at 50 kHz ($P = 0.03$) and an increase in NT-proBNP concentrations ($P = 0.02$) were observed in parallel with the progression of MMVD in this group of CKCS between the two time points. These preliminary findings suggest the potential clinical application of BIA in dogs, emphasizing the need for further research to determine whether PhA could serve as a valuable diagnostic and prognostic marker in cardiac diseases, as it has already been established in human patients.

High-quality mammographic images are necessary because lesions on mammograms are sometimes difficult for the physician to interpret as they are faint and microscopic. In addition, the breast requires minimal radiation exposure. Current photon counting leads to energy- integrated images, not photon-counting images, which instead are based on individual photons. In [6], Authors focused on a mammography system and constructed a novel scheme to experimentally and accurately compare photon-counting images with energy integrated images, where these two types of images are compared at the same total X-ray photon fluence using the same X-ray detection system. In the detecting device, a CsI(Tl) scintillator with columnar crystals is directly glued to the imaging face of a sensitive image sensor. Photon-counting and energy-integrated images were captured with different frame rates and tube currents, while the positional setting of each piece of equipment remained the same. The results showed that the gold discs in the CDMAM3.4 phantom were visually detectable in both energy-integrated and photon-counting images, although the image quality was different, consistent with the simulation. However, the detection devices are small and a larger size is essential for clinical applications.

The article in [7] presents a physical model of a two-electrode conductivity cell with holes for filling located in the electrodes. The study investigates the non-uniformity of the current density distribution within the cell, caused by the presence of these holes. Using the finite element method (FEM), the electrical resistance bias of the cell is calculated and compared to an idealized model - a liquid column with specific geometric dimensions and a uniform field inside. A comparison of the resistance bias values between two models - one with end holes (located in the electrodes) and one with lateral liquid supply - is conducted. The results demonstrate that the resistance bias is highly dependent on the diameter of the holes and is mostly unaffected by their position. In most cases, the resistance bias of the model with holes in the electrodes is 3–6 % lower in absolute value compared to the model with side holes, assuming identical geometric parameters for the cell.

Digitalisation is considered one of the new technical tools in metrology; it is a general strategic issue concerning the future treatment of human knowledge in progress. Digitalisation has reached a dominant status also in data science, inducing a collation of an amount of "data", i.e. of potential information, that is by now by far quantitatively enormously wider than ever before in the science history. It is called Big Data and it is widely recognized. However, it is also considered to be able to replace some of the traditional handling tools in the relevant scientific information, namely the metrological ones. It is called "dataism". The comment paper in [8] proposes some reflections on Big Data handling as an additional challenge also for metrology, with suggestions on possible improvement. In fact, its regulatory field should be taken into account and is supposed to provide guidelines to the new concepts.

LiDARs hold promise for various automotive applications, but their performance in adverse weather conditions remains a severe limitation. Indeed, fog can compromise the ability to perform fundamental tasks such as detection, classification, and tracking. The success of these tasks depends on the quality of the data provided by the LiDAR, i.e., the point cloud, PC, and the algorithms used to analyse that PC. Some previous studies exploited large and sophisticated facilities filled with fog to analyse LiDARs in fog. However, such facilities are intrinsically highly complex and costly. To overcome these limitations, the Authors in [9] propose a much less expensive method based on a fog chamber, a 1 m side transparent chamber to be placed between the LiDAR and the targets, then filled with fog. The proposed method allows for the analysis and comparison of the performance of both LiDARs and processing algorithms while avoiding the cost and complexity of large facilities and the limitations intrinsic to mathematical modelling and numerical simulation. To provide examples of the information that is obtainable using the proposed method, the results from a popular LiDAR and processing algorithm, namely, the Velodyne VLP 16, and the MATLAB® Computer Vision Toolbox, are also reported.

In the residential building sector, a sustainable human-environment relationship can be achieved by encouraging both the use of renewable sources and the enhancement of energy efficiency in technical systems and building envelopes. The article in [10] performs an energy analysis to evaluate the reduction in energy demand attained by installing two Trombe walls on the south-facing wall of the variable orientation test station at the University of Calabria. The two passive systems were symmetrically placed on either side of the existing window system. The assessment of monthly energy demand during the heating season was conducted using the dynamic simulation software DesignBuilder®. To determine the optimal configuration of the Trombe walls, the influence on energy demand related to the materials used for the support structure, the type and number of glasses forming the solar space, the size of the solar space, and the dimensions of the vents were evaluated. The findings indicate that the installation of the two Trombe walls, each comprising two vents with an area of 0.1 m² and a solar space depth of 0.20 m, vertically enclosed by three glass walls with double low-emissivity glazing, results in a 60.62 % reduction in winter energy demand.

Voltage regulation ensures the reliable and efficient operation of power systems by maintaining voltage levels within specified limits despite changing load conditions. Anyway, modern grids integrating renewable energy sources face new challenges. These sources, such as wind and solar power, cause rapid power fluctuations. Furthermore, high-demand loads like electric vehicles could also result in very fast power variations. The paper in [11] explores an advanced control strategy related to the integration of Flexible AC Transmission Systems (FACTS) devices within an improved Secondary Voltage Regulation (SVR) based on an optimal linear quadratic control. The control strategy can compensate the effects of fast load variations, by exploiting the information provided by the Phasor Measurement Units (PMUs). The PMUs are, however, affected by non-idealities, which can reduce the compensation efficiency. In the paper, the performance of the regulation strategy is assessed according to the two main PMU characteristics: the report rate and the accuracy associated with the measurement results. The paper thus provides a walkthrough to properly select the characteristics and, thus, the cost of the PMU, according to the desired voltage regulation performance.

I hope you will enjoy your reading.

Francesco Lamonaca
Editor in Chief

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