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Introductory notes for the Acta IMEKO third issue 2022

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Dear Readers,

The third issue 2022 of Acta IMEKO collects contributions related to two events organized by IMEKO TC17, the IMEKO Technical Committee on Robotic Measurement [1]-[9], and, as usual, papers that do not relate to a specific event and are collected into the general track [10]-[18].

Annually TC17 organizes the "International Symposium on Measurements and Control in Robotics" (ISMCR), a full-fledged event, focusing on various aspects of international research, applications, and trends related to robotic innovations for benefit of humanity, advanced human-robot systems, and applied technologies, e.g. in the allied fields of telerobotics, telexistance, simulation platforms and environments, and mobile work machines as well as virtual reality (VR), Augmented Reality (AR) and 3D modelling and simulation. The introduction to the papers relatd to this event is given in the editorial authored by prof. Zafar Taqvi, organizer of this special issue.

As Editor in Chief, it is my pleasure to give readers an overview of general track papers, with the aim of encouraging potential Authors to consider sharing their research through Acta IMEKO.

Additive Manufacturing (AM) is becoming a widely employed technique also in mass production. In this field, compliances with geometry and mechanical performance standards represent a crucial constrain. Since 3D printed products exhibit a mechanical behaviour that is difficult to predict and investigate due to the complex shape and the inaccuracy in reproducing nominal sizes, optical non-contact techniques are an appropriate candidate to solve these issues. In the paper "Measurement of the structural behaviour of a 3D airless wheel prototype by means of optical non-contact techniques"[10] by Antonino Quattrocchi et al., the 2D digital image correlation and thermoelastic stress analysis are combined to map the stress and the strain performance of an airless wheel prototype. The innovative airless wheel samples are 3D-printed by fused deposition modelling and stereolithography in poly-lactic acid and photopolymer resin, respectively. The static mechanical behaviour for different wheel-ground contact configurations is analysed using the aforementioned non-contact techniques. Moreover, the wheel-ground contact pressure is mapped, and a parametric finite element model is developed. The results presented in the paper demonstrate that several factors have a great influence on 3D printed airless wheels: a) the material used for manufacturing the specimen, b) the correct transfer of the force line (i.e., the loading system), c) the geometric complexity of the lattice structure of the airless wheel. The work confirms the effectiveness of the proposed non-contact measurement procedures for characterising complex-shaped prototypes manufactured using AM.

Body impedance analysis (BIA) is used to evaluate the human body composition by measuring the resistance and reactance of human tissues with a high-frequency, low-intensity electric current. Nonetheless, the estimation of the body composition is influenced by many factors: body status, environmental conditions, instrumentation, and measurement procedure. Valerio Marcotuli et al., in "Metrological characterization of instruments for body impedance analysis", [11] present the results of a study about the effect of the connection cables, conductive electrodes, adhesive gel, and BIA device characteristics on the measurement uncertainty. Tests were initially performed on electric circuits with passive elements and on a jelly phantom simulating the body characteristics. Results showed that the cables mainly contribute to increase the error on the resistance measurement, while the electrodes and the adhesive introduce a negligible disturbance on the measurement chain. The Authors also propose a calibration procedure based on a multivariate linear regression to compensate for the systematic error effect of BIA devices.

Sergio Moltò et al. in the paper "Uncertainty in mechanical deformation of a Fabry-Perot cavity due to pressure: towards best mechanical configuration" [12] present a study about the deformation of a refractometer used to achieve a quantum realization of the Pascal. First, the propagation of the uncertainty in the pressure measurement due to mechanical deformation was assessed. Then, deformation simulations were carried out with a cavity designed by the CNAM (Conservatoire National des Arts

et Métiers). This step aims to corroborate the methodology used in the simulations.

The assessment of modal components is a fundamental step in structural dynamics. While experimental investigations are generally performed through full-contact techniques, using accelerometers or modal hammers, the research proposed in the paper entitled "Frequency response function identification using fused filament fabrication-3D-printed embedded ArUco markers" [13], by Lorenzo Capponi et al, presents a non-contact frequency response function identification measurement technique based on ArUco square fiducial markers displacement detection. A video of the phenomenon to be analyzed is acquired, and the displacement is measured through markers, using a dedicated tracking algorithm. The proposed method is presented using a harmonically excited FFF 3D-printed flexible structure, equipped with multiple embedded-printed markers, whose displacement is measured by an industrial camera. Comparison with numerical simulation and an established experimental approach is finally provided for the validation of the results.

Human movement modeling - also referred to as motion-capture - is a rapidly expanding field of interest for medical rehabilitation, sports training, and entertainment. Motion capture devices are used to provide a virtual 3-dimensional reconstruction of human physical activities - employing either optical or inertial sensors. Using inertial measurement units and digital signal processing techniques offers a better alternative in terms of portability and immunity to visual perturbations when compared to conventional optical solutions. In the paper "Low-cost real-time motion capturing system using inertial measurement units" [14], Simona Salicone et al. propose a cable-free, low-cost motion-capture solution based on inertial measurement units with a novel approach for calibration. The goal of the proposed solution is to apply motion capture to the fields that, because of cost problems, did not take enough benefit of such technology (e.g., fitness training centers). According to this goal, the necessary requirement for the proposed system is to be low-cost. Therefore, all the considerations and all the solutions provided in this work have been done according to this main requirement.

Maximum-Power Extrapolation (MPE) techniques adopted for 4G and 5G signals are applied to systems using Dynamic Spectrum Sharing (DSS) signals generated by a base station and transferred to the measurement instruments through an air interface adapter to obtain a controlled environment. This allowed to focus the analysis on the effect of the frame structure on the MPE procedure, excluding the random effects associated to fading phenomena affecting signals received in real environments. The analysis presented by Sara Adda et al in the paper "Experimental investigation in controlled conditions of the impact of dynamic spectrum sharing on maximum-power extrapolation techniques for the assessment of human exposure to electromagnetic fields generated by 5G gNodeB" [15] confirms that both the 4G MPE and the proposed 5G MPE procedure can be used for DSS signals, provided that the correct number of subcarriers in the DSS frame is considered.

Michela Albano et al., in the paper entitled "X-rays investigations for the characterization of two 17th century brass instruments from Nuremberg", [16] propose a multidisciplinary approach mainly based on non-invasive analytical techniques and including X-rays investigations (X-ray radiography, X-ray fluorescence and X-ray diffraction) for the study of two brass natural horns from the end of the 17th recently found in Castello Sforzesco in Milan (Italy). These findings brought new information about this class of objects; actually, even though the instruments were heavily damaged, their historical value was great. The study proposed in the paper was aimed at: i) pointing out the executive techniques for archaeometric purposes; ii) characterizing the morphological and chemical features of materials; iii) identifying and mapping the damages of the structure and the alterations of the surface.

In the paper "Non-destructive investigation of the Kyathos (6th-4th centuries BCE) from the necropolis Volna 1 on the Taman Peninsula by neutron resonance capture and X-ray fluorescence analysis" [17] Nina Simbirtseva et al. propose the method of Neutron Resonance Capture Analysis (NRCA) to determine the elemental and isotope compositions of objects non-destructively, which makes it a suitable measurement tool for artefacts analysis without sampling. The method is currently being developed at the Frank Laboratory of Neutron Physics. NRCA is based on the registration of neutron resonances in radiative capture and on the measurement of the yield of reaction products in these resonances.

The potential of NRCA at the Intense Resonance Neutron Source facility is demonstrated on the investigation of a Kyathos from the necropolis Volna 1 (6th-4th centuries BCE) on the Taman Peninsula. In addition, X-ray fluorescence (XRF) analysis was applied to the same object. The elemental composition determined by NRCA is in agreement with XRF data.

A power system in which the generation units such as renewable energy sources and other types of generation equipment are located near loads, thereby, reducing operation costs and losses and improving voltage is referred to as 'distributed generation' (DG), and these generation units are named 'distributed energy resources'. However, DGs must be located appropriately to improve the power quality and minimize power loss of the system. The objective of the paper entitled "Performance enhancement of a low-voltage microgrid by measuring the optimal size and location of distributed generation" [18] by Ahmed Jassim Ahmed et al., is to propose an approach for measuring the optimal size and location of DGs in a low voltage Microgrid using the Autoadd algorithm. The algorithm is validated by testing it on the IEEE 33-bus standard system and, compared with previous studies, the algorithm proved its efficiency and superiority on the other techniques. A significant improvement in voltage and reduction in losses were observed when the DGs are placed at the sites selected by the algorithm. Therefore, Autoadd was used in finding the optimal size and location of DGs in the distribution system; then, the possibility of isolating the low voltage Microgrid is discussed by integrating distributed generation units and the results showed the possibility of this scenario during faults time and intermittency of energy time.

Also in this issue, high quality and heterogeneous papers are presented, confirming Acta IMEKO as the natural platform for disseminating measurement information and stimulating collaboration among researchers from many different fields. In particular, the technical note shows how Acta IMEKO is the right place where different opinions and point of views can meet and compare, stimulating a fruitful and constructive debate in the scientific community of measurement science.

I hope you will enjoy your reading.

Francesco Lamonaca
Editor in Chief

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