

# Introductory notes for the Acta IMEKO second issue 2022

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Dear Readers,

The second issue 2022 of Acta IMEKO collects contributions that do not relate to a specific event. As editor-in-chief, it is my pleasure to give readers an overview of these papers, with the aim of encouraging potential Authors to consider sharing their research through Acta IMEKO.

Modern applications in virtual reality require a high level of fruition of the environment as if it was real. In applications that have to deal with real scenarios, it is important to acquire both its three-dimensional (3D) structure and details to enable the users to achieve good immersive experiences. In the paper entitled “Omnidirectional camera pose estimation and projective texture mapping for photorealistic 3D virtual reality experiences”, by A. Luchetti et al., the Authors propose a method to obtain a mesh with high quality texture combining a raw 3D mesh model of the environment and 360° images. The main outcome is a mesh with a high level of photorealistic details.

The paper entitled “The importance of physiological data variability in wearable devices for digital health applications”, by G. Cosoli et al., aims at characterizing the variability of physiological data collected through a wearable device (Empatica E4), given that both intra- and inter-subject variability play a pivotal role in digital health applications, where Artificial Intelligence (AI) techniques have become popular. Inter-beat intervals (IBIs), ElectroDermal Activity (EDA), and Skin Temperature (SKT) signals have been considered and variability has been evaluated in terms of general statistics (mean and standard deviation) and coefficient of variation. Results show that both intra- and inter-subject variability values are significant, especially when considering those parameters describing how the signals vary over time. Moreover, EDA seems to be the signal characterized by the highest variability, followed by IBIs, contrary to SKT which results more stable.

S. Avdiaj et al., in the paper “Measurements of virial coefficients of Helium, Argon and Nitrogen for the needs of static expansion method”, study the influence of virial coefficients on the realization of primary standards in vacuum

metrology, especially in the realization of the static expansion method. In the paper they present the measured data for virial coefficients of three gases, namely Helium, Argon, and Nitrogen, measured at room temperature and a pressure range from 3 kPa to 130 kPa.

In the new optical pressure standard Ultra-Low Expansion (ULE) glass cavities were proposed to measure helium refractivity for a new realisation of the unit of pressure, pascal. However, it was noticed that the use of this type of material causes some difficulties. One of the main problems of ULE glass is the pumping effect for Helium. Therefore, instead of ULE, Zerodur glass was proposed as a material for the cavity. This proposal was given by the Vacuum Metrology team of the Physikalisch-Technische Bundesanstalt - PTB in the QuantumPascal project. In order to calculate the flow of helium gas through Zerodur glass one has to know the permeation constant K. In the paper “Measurements of helium permeation in Zerodur glass used for the realisation of quantum pascal”, A. Kurtishaj et al. measured the permeation of helium gas in Zerodur in the temperature range from 80 °C to 120 °C. Experimental results assess that Zerodur material has the potential to be used as cavity material for the new quantum standard of pressure.

S. Ondera et al., in the paper entitled “Dose reduction potential in dual-energy subtraction chest radiography based on the relationship between spatial-resolution property and segmentation accuracy of the tumor area”, investigated the relationship between the spatial-resolution property of soft tissue images and the lesion detection ability using U-net. The aim of the paper is to explore the possibility of dose reduction during energy subtraction chest radiography.

An informed type A evaluation of standard uncertainty is derived in the paper entitled “An informed type A evaluation of standard uncertainty valid for any sample size greater than or equal to 1”, authored by C. Carobbi, based on Bayesian analysis. The result is mathematically simple, easily interpretable, applicable both in the theoretical framework of the Guide to the Expression of Uncertainty in Measurement (propagation of



standard uncertainties) and in that of the Supplement 1 of the Guide (propagation of distributions), valid for any size greater than or equal to 1 of the sample of present observations.

G. Campobello et al., in the paper “On the trade-off between compression efficiency and distortion of a new compression algorithm for multichannel EEG signals based on singular value decomposition” investigate the trade-off between the compression ratio and distortion of a recently published compression technique specifically devised for multichannel electroencephalograph (EEG) signals. This paper extends a previous one in which the Authors proved that, when singular value decomposition (SVD) is already performed for denoising or removing unwanted artifacts, it is possible to exploit the same SVD for compression purpose by achieving a compression ratio in the order of 10 and a percentage root mean square distortion in the order of 0.01 %. In this article, Authors successfully demonstrate how, with a negligible increase in the computational cost of the algorithm, it is possible to further improve the compression ratio by about 10 % by maintaining the same distortion level or, alternatively, to improve the compression ratio by about 50 % by still maintaining the distortion level below the 0.1 %.

In the paper entitled “A strategy to control industrial plants in the spirit of Industry 4.0 tested on a fluidic system”, L. Fabiano et al. propose a strategy of automating the control of wide spectrum industrial processes plants in the spirit of Industry 4.0. The strategy is based on the creation of a virtual simulator of the operation of the plants involved in the process. Through the digitization of the operational data sheets of the various components, the simulator can provide the reference values of the process control parameters to be compared with their actual values, to decide the direct inspection and/or the operational intervention on critical components before a possible failure.

N. Covre et al., in “Monte Carlo-based 3D surface point cloud volume estimation by exploding local cubes faces”, propose a state-of-the-art algorithm for estimating the 3D volume enclosed in a surface point cloud via a modified extension of the Monte Carlo integration approach. The algorithm consists of a pre-processing of the surface point cloud, a sequential generation of points managed by an affiliation criterion, and the final computation of the volume. The pre-processing phase allows a spatial re-orientation of the original point cloud, the evaluation of the homogeneity of its points distribution, and its enclosure inside a rectangular parallelepiped of known volume. The affiliation criterion using the explosion of cube faces is the core of the algorithm, it handles the sequential generation of points, and proposes the effective extension of the traditional Monte Carlo method by introducing its applicability to the discrete domains.

In the paper “3D shape measurement techniques for human body reconstruction”, I. Xhimitiku et al. investigate and compare the performances of three different techniques for 3D scanning. In particular, two commercial tools (smartphone camera and iPad Pro LiDAR) and a structured light scanner (Go!SCAN 50) have been used for the analysis. First, two different subjects have been scanned with the three different techniques and the obtained 3D models were analysed in order to evaluate the respective reconstruction accuracy. A case study involving a child was then considered, with the main aim of providing useful information on performances of scanning techniques for clinical

applications, where boundary conditions are often challenging (e.g. non-collaborative patient). Finally, a full procedure for the 3D reconstruction of a human shape is proposed, in order to set up a helpful workflow for clinical applications.

High-resolution X-ray computed micro-tomography (CT) is a powerful technique for studying the processes of crack propagation in non-homogenous quasi-brittle materials such as rocks. To obtain all the significant information about the deformation behaviour and fracture characteristics of the studied rocks, the use of a highly specialised loading device suitable for the integration into existing tomographic setups is crucial. Since no adequate commercial solution is currently available, a completely newly-designed loading device with a four-point bending setup and vertically-oriented scanned samples is proposed and used in the paper “Study of fracture processes in sandstone subjected to four-point bending by means of 4D X-ray computed micro-tomography”, authored by L. Vavro et al. This design of the loading procedure, coupled with the high stiffness of the loading frame, allows the loading process to be interrupted at any time and for CT scanning to be performed without the risk of the sudden destruction of the scanned sample.

M. S. Latha Gade et al. in the paper “A cost-efficient reversible logic gates implementation based on measurable quantum-dot cellular automata” describe experimental and analytic approaches for measuring design metrics of reversible logic gates using Quantum-dot cellular automata (QCA), such as ancilla input, garbage output, quantum cost, cell count, and area, while accounting for the effects of energy dissipation and circuit complexity. The parameters of reversible gates with modified structures are measured and then compared with the existing designs.

Human facial expressions are thought to be important in interpreting one's emotions. Emotional recognition plays a very important part in the more exact inspection of human feelings and interior thoughts. Over the last several years, emotion identification utilizing pictures, videos, or voice as input has been a popular issue in the field of study. Recently, most emotional recognition research focuses on the extraction of representative modality characteristics and the definition of dynamic interactions between multiple modalities. Deep learning methods have opened the way for the development of artificial intelligence products, and the suggested system employs a convolutional neural network (CNN) for identifying real-time human feelings. The aim of the research study proposed by K. Pranathi et al. in the paper “Video-based emotion sensing and recognition using convolutional neural network based kinetic gas molecule optimization” is to create a real-time emotion detection application by utilizing improved CNN. This research offers information on identifying emotions in films using deep learning techniques. Kinetic gas molecule optimization is used to optimize the fine-tuning and weights of CNN.

In “Development of a contactless operation system for radiographic consoles using an eye tracker for severe acute respiratory syndrome coronavirus 2 infection control: a feasibility study”, M. Sato et al. propose noncontact operation system for radiographic consoles that used a common eye tracker system facilitating noncontact operation of radiographic consoles for patients with COVID-19 to reduce the need for frequent disinfection. Experimental tests show that the proposal can be applied even if the operator uses a face shield. Thus, its



application could be important in preventing the transmission of infections.

J. Y. Blaise et al. in “Acquisition and integration of spatial and acoustic features: a workflow tailored to small-scale heritage architecture” report on an interdisciplinary data acquisition and processing chain, the novelty of which is primarily to be found in a close integration of acoustic and spatial data. The paper provides a detailed description of the technological and methodological choices that were made in order to adapt to the particularities of the corpus studied (interiors of small scale rural architectural artefacts). The research outputs pave the way for proportion-as-ratios analyses, as well as for the study of perceptual aspects from an acoustic point of view. Ultimately, “perceptual” acoustic data characterised by acoustic descriptors will be related to “objective” spatial data such as architectural metrics.

Multiplication provides a substantial impact on metrics like power dissipation, speed, size and power consumption. A modified approximate absolute unit is proposed by Y. Nagaratnam et al. in the paper “A modified truncation and rounding-based scalable approximate multiplier with minimum error measurement” to enhance the performance of the existing approximate multiplier. The proposed multiplier can be applied in image processing and shows an error of 0.01% while actual solutions show a typical error of 0.40%.

Always in the field of approximate multipliers, in “Low-power and high-speed approximate multiplier using higher order compressors for measurement systems”, M. V. S. Ram Prasad et al. proposed an innovative architecture that in the

implementation of a FIR filter allows to achieve a delay of 27 ns versus the 119 ns achieved by the exact multiplier taken as reference.

Finally, the technical note authored by Franco Pavese is a comment which addresses the paper published in this Journal “Is our understanding of measurement evolving?” and authored by Luca Mari. This Technical Note concerns specific parts of that paper, namely the statements: “doubt: isn’t metrology a ‘real’ science? ... Metrology is a social body of knowledge”, “Measurements are aimed at attributing values to properties: since values are information entities, any measurement must then include an informational component” and “What sufficient conditions characterise measurement as a specific kind of property evaluation?”, and discusses alternatives.

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 points of view 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