

Guest Editorial

Special Section on IEEE MeMeA 2022

Metrological Point of View in Medical Measurements

The 2022 edition of the IEEE International Symposium on Medical Measurements and Applications (IEEE MeMeA 2022) has been held in presence on June 22–24, 2022, in the magnificent surroundings of Giardini Naxos, Sicily, Italy. The event has been greeted by numerous attendees as the reference event in the sector of measurement science applied to medicine. This 17th edition of the symposium has seen the participants meeting in presence after two years of virtual meetings, enhancing the professional and scientific inter-exchange of ideas and views. The history of Sicily and its culture have guaranteed the optimal working contest for researchers presenting and discussing the more recent advancements of research in this field. Over the years—the first edition dates back to 2006—the MeMeA series of workshops and symposia have registered a growing number of participants and a substantial increase in the quality of the contributions presented.

The MeMeA 2022 Technical Program have included 178 research contributions, peer-reviewed by 94 experts with different background and professional sectors. Five regular sessions, 18 special sessions, and two poster sessions have been organized, exploring the most advanced research topics in the medicine and measurement fields: Machine learning, sensors and transducers, artificial intelligence in medical diagnostic, microwave sensing in medicine, measurement in human locomotion, smart health, micro devices and miniaturized nano-transducers, sensing systems for aging people, sensors and technologies for preventing air-borne infection spreading, contact-less health monitoring, innovative biosensors, fiber-optic technology for medical applications, wearables for physiological signals, and electrochemical impedance spectroscopy in biomedical measurements.

Organizers have invited Prof. Wang (San Diego University of California, San Diego, CA, USA) for a keynote talk on “Wearable Electrochemical Sensors: Toward Biochemical Lab on the Body,” and Prof. Eugenio Martinelli (University of Rome Tor Vergata, Rome, Italy) for a keynote talk on “The Importance of Machine Learning in the Exploitation of Organ-on-Chip Experiments.” Two tutorial sessions have also attracted the attention of the participants: “Compressed Sensing for Physiological Signals in Internet of Medical Things Systems” by Luca De Vito (Università degli Studi

del Sannio, Benevento, Italy) and “Surface Electromyography to Understand How Muscles Make You Move” by Silvia Conforto (University Roma Tre, Rome).

As announced by the Scientific Committee, authors of the manuscripts accepted for publication in the *MeMeA 2022 Proceedings* were invited to consider the possibility to extend their work and to submit their manuscript to this Special Issue, which intends to promote the best results presented at the symposium from the perspective of instrumentation and measurement. In response to this opportunity, 21 original manuscripts were submitted to the IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT. After careful peer reviewing, 12 manuscripts were finally selected for publication in this Special Issue. The high number of submitted contributions is a clear sign of the constantly growing attention of the I&M community toward topics such as metrology in medical fields, monitoring systems and sensors for healthcare, and also the need for solutions aimed to simplify the difficult interaction between the measurement world and the medicine area.

Concerning the finally selected papers, it should be noted how topics range from novel ideas on sensor design and measuring methodologies to uncertainty aspects and clinical/patient measurement data.

In [A1], Ferlazzo et al. studied the possibility to develop a novel potentiometric enzymatic biosensor for the real-time monitoring of phenylalanine. The sensor, based on a commercial substrate with screen-printed electrodes, was functionalized immobilizing the phenylalanine dehydrogenase enzyme on the electrode without using any membrane. Sensing characterizations were carried out demonstrating the feasibility of the sensor for phenylalanine monitoring in patients affected with phenylketonuria.

In [A2], Chiera et al. assessed the total filtration efficiency of surgical and community face masks for 50 different face mask models trying of understanding the effects of several mask design features on the air leaking at the face seal. With this aim, an experimental instrumented head was developed in order to assess airflow and leakage. The experimental results showed a total filtration efficiency ranging from 5% to 73% highlighting the importance of face mask design and materials.

The measurement of energy metabolism in humans is the topic of the article [A3] by Bandini et al. The article formally studies the sensitivity and uncertainty sources of whole-room indirect calorimeters employed for metabolic measurement in a push configuration at the steady-state condition in order

to assess the optimal operative conditions. The experimental results showed how the relative uncertainty of the metabolic measurement can be maintained under 5%.

A different topic is instead addressed in [A4] by Carullo et al., where the main aim was to identify an effective methodology for assessing post-operation phonatory impairments in patients who underwent partial laryngectomy and evaluating the effectiveness of rehabilitation therapies. A dataset of recordings of 85 patients was used in the study. Two different feature selection techniques were analyzed showing how the best classification accuracy is obtained using a logistic regression model.

In [A5], Gugliandolo deals with the development and the characterization of a planar microwave sensor for the dielectric characterization of biological samples based on two capacitively coupled split-ring resonators fabricated by ink-printing. The experimental results obtained with a water-ethanol mixture demonstrated the feasibility of the sensor for detecting variations of ethanol concentration by means of differential measurements.

In [A6], Rodrigues et al. study the effects of sound stimulation, such as music and noise, on the autonomous nervous system brain function and cardiac activity by collecting physiological data from volunteers. Heart rate variability and electrodermal activity were analyzed with the final goal to mitigate stress levels by integrating musical stimuli in a smart environment. The experimental results show an increase of sympathetic activity with stressful noise while ambient music increases parasympathetic activity and comfort level.

In [A7], Kyrollos et al. present a novel multimodal infant mannequin lying pose dataset for under-cover infant pose monitoring obtained by collecting depth and pressure images of an infant mannequin lying in different poses under various cover conditions. The authors are able to infer the full body pose and accurately estimate the joint positions under the cover by employing state-of-art estimation methods and models together with transfer learning of multimodal adult pose datasets.

Instead, [A8], by Hagen et al., is related to preventive medicine. The authors developed a point-of-care cost-effective device for portable fluorescence measurements which employs a constant output-power laser optical module that can be easily replaced according to the specific application. Moreover, a precision switched-input transimpedance amplifier ensures high sensitivity over a wide range of fluorescence intensities. Ex-vivo and in-vivo measurements confirm the good performance of the device.

[A9], by Rifi et al., addresses a different problem: provide a biological meaning to the radiomic features extracted from tumor machine learning models. The authors propose a novel approach where the radiomic features extracted from computed tomography scans of murine tumor models were analyzed with an exploratory factor analysis. The results show that it is possible to discriminate the type of tumor and the inflammatory response starting from the radiomic features.

Mencattini et al. [A10] propagate the uncertainty through a platform for image analysis based on variational auto-encoders applied to the melanoma disease. The goal is to estimate the

uncertainty of descriptors of melanoma malignancy with the aim of selecting descriptors more robust against to skin tone variations and gel bubble effects. The results show that the proposed feature selection improves the prediction accuracy with respect to classic deep-learning methods.

An electrochemical sensor based on silver nanoplates is presented in [A11] by Zribi et al. Cyclic voltammetry, linear sweep voltammetry, and simulations were used to characterize and study the sensing performance toward H_2O_2 , a model analyte of reactive species involved in the regulation of metabolic and inflammatory diseases. The results of the article show very interesting results.

Eventually, Bhaiyya et al. [A12] address some of the electrochemiluminescence (ECL) sensor issues, including nonlinearity, multidimensionality, and sensor-to-sensor output variability by employing machine-learning methods. The authors apply this approach to an ECL commercial system and a smartphone as a platform for detecting several biomarkers. The results highlight an accuracy improvement making the platform suitable for real-world applications.

It is with great pleasure that we introduce this Special Session from the 17th edition of the IEEE International Symposium on Medical Measurements and Applications (IEEE MeMeA 2022), and we would like to thank all authors who have contributed. We would also take this opportunity to thank the conference and journal reviewers as well as associated editors for their precious work.

We also would like to thank the IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT staff and Prof. Ruqiang Yan, Editor-in-Chief, for their support and efficient services for the publication of this Special Issue.

We hope that the content of this Special Issue can catch the interest of magazine readers, not only those involved in measurements and instrumentation but also scientists and physicians.

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APPENDIX: RELATED ARTICLES

- [A1] A. Ferlazzo, C. Espro, D. Iannazzo, and G. Neri, "Determination of phenylalanine by a novel enzymatic PHD/SPE biosensor," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–8, 2023.
- [A2] S. Chiera et al., "Measuring total filtration efficiency of surgical and community face masks: Impact of mask design features," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–17, 2023.
- [A3] G. Bandini, A. Landi, F. Santini, A. Basolo, M. Marracci, and P. Piaggi, "Sensitivity analysis of whole-room indirect calorimeters at the steady-state condition," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–8, 2023.

- [A4] A. Carullo, A. Vallan, M. Fantini, and G. Succo, "Vocal-Feature-Based classification of post-laryngectomy patients for rehabilitation monitoring," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–9, 2023.
- [A5] G. Gugliandolo, G. Vermiglio, G. Cutroneo, G. Campobello, G. Crupi, and N. Donato, "Development, characterization, and circuit modeling of inkjet-printed coupled ring resonators for application in biological samples," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–10, 2023.
- [A6] M. C. J. Rodrigues, O. Postolache, and F. Cercas, "The influence of stress noise and music stimulation on the autonomous nervous system," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–19, 2023.
- [A7] D. G. Kyrollos, A. Fuller, K. Greenwood, J. Harrold, and J. R. Green, "Under the cover infant pose estimation using multimodal data," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–12, 2023.
- [A8] R. Hagen, D. Fehr, F. Spano, S. Babity, D. Brambilla, and M. Bonmarin, "Portable multiwavelength fluorescence measurement device: Empirical evaluation," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–9, 2023.
- [A9] A. L. Rifi, I. Dufait, C. E. Aisati, M. De Ridder, and K. Barbé, "Interpretability and repeatability of radiomic features: Applied on in vivo tumor models," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–7, 2023.
- [A10] A. Mencattini, P. Casti, M. D'Orazio, G. Antonelli, J. Filippi, and E. Martinelli, "Uncertainty-based feature selection for improved adequacy of dermoscopic image classification," *IEEE Trans. Instrum. Meas.*, early access, Aug. 9, 2023, doi: [10.1109/TIM.2023.3303498](https://doi.org/10.1109/TIM.2023.3303498).
- [A11] R. Zribi et al., "Ag nanoplates modified-screen printed carbon electrode to improve electrochemical performances toward a selective H₂O₂ detection," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–8, 2023.
- [A12] M. L. Bhaiyya, S. K. Srivastava, P. K. Pattnaik, and S. Goel, "Closed-bipolar mini electrochemiluminescence sensor to detect various biomarkers: A machine learning approach," *IEEE Trans. Instrum. Meas.*, vol. 72, pp. 1–8, 2023.



Lorenzo Scalise (Senior Member, IEEE), received the M.S. degree in electronic engineering from Università degli Studi di Ancona, Ancona, Italy, in 1996, and the Ph.D. degree in mechanical measurement for engineering from Università degli Studi di Padova, Padua, Italy, in 1999.

Since November 2015, he has been an Associate Professor with the Faculty of Engineering, Università Politecnica delle Marche, Ancona. He is the author of more than 250 papers in international journals and conference proceedings. His research interests are in the field of measurement techniques, with a special focus on sensors, instrumentation and data acquisition, biomedical instrumentation, assistive technologies, e-health, optical sensors, and characterization of systems and materials.

Dr. Scalise has been a member of the IEEE Instrumentation and Measurement Society since 2010 and a Senior Member of the International Society for Optics and Photonics (SPIE) and the Society of Experimental Mechanics (SEM) since 2020. He was a Technical Program Chair of IEEE-MeMeA in 2018 and 2019. He has been a Guest Editor of the MeMeA Special Issues of IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT for the 2018 and 2019 symposium editions.



Luca Lombardo (Member, IEEE) received the B.S. and M.S. degrees in electronic engineering from the University of Messina, Messina, Italy, in 2014 and 2016, respectively, and the Ph.D. degree in metrology from Politecnico di Torino, Turin, Italy, in 2019.

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