Introductory notes for the Acta IMEKO special issue on the 17th IMEKO technical committee 10 conference 'Global trends in testing,

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Introductory notes for the Acta IMEKO Special Issue on the 17th IMEKO Technical Committee 10 Conference 'Global trends in testing, diagnostics & inspection for 2030' (2nd conference jointly organised by IMEKO and EUROLAB aisbl)

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DEAR READERS,

The area of technical diagnostics is one of the most significant research fields, one that involves a broad range of measurements, with various sensors, actuators and advanced computing techniques exploited. As we are becoming increasingly surrounded by the growing amount of autonomous machinery, it is crucial to ensure regular and accurate monitoring is carried out. The Technical Committee 10 (Measurement for Diagnostics, Optimization & Control) is responsible for fostering the research on such topics, which is expressed in terms of a wide range of activities, including the organisation of annual conferences and workshops aimed solely at the problems pertaining to fault detection, identification and location. The solutions for these problems include the array of algorithms, measurement tools and procedures applicable for individual devices and industrial processes. The 17th IMEKO TC10 conference held in 2020 is a perfect example of this approach.

The conference was special for two reasons, the first of which relates to the COVID-19 pandemic, which forced us to switch the location, originally planned for Dubrovnik, Croatia, to the purely virtual world. The event was then held online, using various internet technologies. This was entirely new to all involved and forced us to use new channels of communications and information-sharing techniques (e.g., cloud services and teleconferences) on an unprecedented scale. Despite these challenges, the online event was met with great enthusiasm by both the participants and the invited guests.

The second unique feature of the 2020 conference was that it was the second event co-organised by IMEKO and EUROLAB (Croatian branch). This broadened the scope of the event to include new specific topics largely related to EUROLAB's interests. The main drawback of the conference was the lost opportunity to visit the beautiful city of Dubrovnik; however, we hope to be able to re-organise the conference there in the more traditional way in the future.

The theme of the conference, 'Global trends in testing, diagnostics & inspection for 2030', was supported by a wide range of topics covered by both existing papers and invited speakers. The problems covered by the speakers included the industrial standards (e.g., ISO 3452, or ISO/IEC 17025), computational methods (reinforcement learning, artificial neural networks, etc.), applications (civil engineering or food industry), advanced measurement equipment (optical sensors or MEMS solutions), and significant measurement challenges (e.g., uncertainty evaluation). It would appear that the constant advancement in electronics and computer technologies has enabled an increasing number of advanced concepts to be realised.

The corresponding special issue covers ten papers, which can be divided into three sections, each devoted to a different topic. The selection allows for assessing the advancements in these research and engineering fields.

The section aimed at presenting and solving the general problems and challenges pertaining to technical diagnostics includes three papers. The first, 'Fault compensation effect in fault detection and isolation', written by Michał Bartyś, considers

the fault compensation effect in fault detection and isolation. This is an important issue in the area of model-based process diagnostics. Here, the author discusses the application of the process graph to accurately represent the monitored phenomenon, allowing for fault detection based on the residuals and diagnostic matrix analysis. The concept is illustrated in terms of examples of the liquid tank and closed-loop liquid level control system.

Meanwhile, in their paper, 'Estimate the useful life for a heating, ventilation, and air conditioning system on a high-speed train using failure models', Marcantonio Catelani et al. cover the problem of the design and application of failure models. Here, the methodology, i.e., exploiting the model-based diagnostic approach, is demonstrated using the case of the HVAC system (both during the simulation and the actual data provided by the manufacturer), with the results demonstrating the capacity of the approach for correctly evaluating the ability of the monitored object.

Finally, in their paper, 'Integrating maintenance strategies in autonomous production control using a cost-based model', Robert Glawar et al. present the novel cost-based model approach for manufacturing-process monitoring. Here, various maintenance strategies for autonomous production control are presented, preceded by the definition of the cost function for comparing their efficiency, while the possible application strategies are also discussed.

The section related to the novel measurement and sensing methods for diagnostics includes five papers. The first, 'Overview of the modified magnetoelastic method applicability', by Tomáš Klier et al., is devoted to the specific type of sensor in exploiting the magnetoelastic method. This method is used in the field of civil engineering to evaluate the state of buildings or construction operations. The important part of this approach is the coil, whereby the strength of the magnetic field can be evaluated. Both the attendant laboratory and field (the bridge structure) tests demonstrated the applicability of the method.

The paper entitled 'Bringing optical metrology to testing and inspection activities in civil engineering', by Luís Martins et al., is focused on the area of optical metrology in the civil engineering field. Here, the dimensional measurements of the concrete structures are supported by specific digital imaging techniques (e.g., CCTV cameras or laser interferometry). Various applications (e.g., bridge monitoring, sewer inspection, earthquake risk analysis) indicate the importance of this type of sensing technology.

Elsewhere, in their paper entitled 'Vibration-based tool life monitoring for ceramics micro-cutting under various toolpath strategies', Zsolt J. Viharos et al. discuss the novel method of monitoring the state of the ceramics cutting machinery using vibration analysis. Here, both the time- and frequency-domain features are exploited in order to evaluate and predict the micro-cutting tool 'wearing out' phenomenon, with the analysis of the selected CNC machine allowing for determining three stages of device degradation.

In their paper, 'Magnetic circuit optimization of linear dynamic actuators', Laszlo Kazup and Angela Varadine Szarka present the linear braking method used in the actuators. Here, the method incorporates the design of the magnetic circuit, with the authors presenting the detailed design and the optimisation procedure for the circuit parameters. The attendant simulations demonstrated that it is possible to optimise the flux leakage and the dimensions of the circuit.

Finally, in their paper entitled 'Analysing and simulating electronic devices as antennas', Dániel Erdősy et al. discuss the electromagnetic compatibility (EMC) properties in relation to the operation of the complex antenna system. Here, the equivalent circuit and the antenna directivity are calculated using the simulation tools, while the antenna arrays and the problems pertaining to the EMC emission are also considered.

Meanwhile, the section that is focused on the computational methods and algorithms in the field of diagnostics includes two papers. The first, 'The improved automatic control points computation for the acoustic noise level audits', by Tomáš Drábek and Jan Holub, presents the post-processing method for the acoustic noise evaluation to estimate the comfort level of specific human living conditions. Here, the control points localisation method is used to optimise the indoor noise measurement, with the attendant algorithm used to identify both long-term stationary and short-term recurring noise. Overall, the authors demonstrate how to select the control points, outline various spatial conditions, and compare different layouts in terms of level evaluation accuracy and computation time.

The second paper, 'Artificial Neural Network-based detection of gas hydrate formation', which was written by Ildikó Bölkény, discusses the application of an artificial neural network to detect and prevent the gas hydrate formations in the area of industrial-process diagnostics. Here, two network architectures (NNARX and NNOE) are used as the regression machines, with the approach tested on the actual test equipment for the hydrate forming process. The results allowed for comparing the implemented network architectures in terms of prediction accuracy.

Suffice it to say, we wish to thank all the esteemed authors for delivering interesting, top-quality papers and all the reviewers who devoted a great deal of time and effort to reading and evaluating the manuscripts. This undoubtedly allowed for preparing the high-quality content of the subsequent ACTA IMEKO issue. Secondly, our gratitude goes to Prof. Francesco Lamonaca, the current editor-in-chief, for his devotion and support during the handling of the papers. We are extremely grateful for the chance to play the role of guest editors and hope that the papers will prove to be both interesting and useful for both research activities and practical applications alike.

Piotr Bilski and Lorenzo Ciani, Guest Editors