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Guest Editorial for Nondestructive Testing and Evaluation (NDT&E) Special Section

NONDESTRUCTIVE testing and evaluation (NDT&E) are diverse fields that span many areas of science and engineering disciplines, while also impacting many industries. The ever-increasing growth and development of complex materials and structures necessitates new and advanced NDT&E methods for manufacturing process control, and in-service flaw detection and evaluation.

This Special Section in the IEEE OPEN JOURNAL OF INSTRUMENTATION AND MEASUREMENT (IEEE OJIM) focuses on recent developments in NDT&E techniques. These include method and system development, advanced physics-based models and algorithms for detection and evaluation, and augmentation of AI/ML in data interpretation and decision-making processes specifically for NDT&E applications.

The first paper by Case and Kenderian [A1] presents a technique for using an X-ray shot to self-determine the X-ray shot geometry. This technique utilizes a set of known constellation markers, finds the global optimal solution by breaking the problem up based on shot geometry, and does final geometry refinement by reprojecting a 3-D model of the reference constellation.

The second paper by Dvorsky et al. [A2] derives an exact formulation of the mode reflection coefficient for a circular waveguide under the following conditions: 1) radiating into a multilayered structure and 2) the waveguide is excited with any combination of axially symmetric modes. The derivation was verified through comparison to 3-D full-wave electromagnetic simulations and measurements. Additionally, forward-iterative optimization techniques were used in conjunction with the presented derivation to accurately estimate the thickness and complex permittivity of thin dielectric layers at microwave frequencies.

The third paper by Zhang et al. [A3] proposed a method to increase the sensor signal level of an electromagnetic tomography (EMT) sensor via boosting transformers. The SNR increase provided by the proposed method was demonstrated through simulation and experimental results. This approach is well suited for high-temperature applications where coils with a large number of turns are often subject to damage.

The fourth paper by Gilmour et al. [A4] presents the development of an image processing-based localization system for remote evaluation of welds. The proposed system relies on live phased array ultrasonic images captured with a robotic manipulator to estimate weld location and was capable of predicting weld position to within an absolute mean positional error of 0.8 mm.

The fifth paper by Deleruyelle et al. [A5] presented a comparison of two different noninvasive methods for the validation and diagnostics of contactless RFID devices. The paper also presented two decision-making approaches based on machine learning that could be applied to the diagnostic data.

The sixth paper by Case et al. [A6] presents complex permittivity measurements from 32 to 40 GHz of yttria-stabilized zirconia (8-YSZ) in powdered and sintered forms. These measurements were made with a circular waveguide probe and were compared to filled rectangular waveguide measurements that were made at three different frequency bands. It was shown that solid 8-YSZ has significantly different complex permittivities in its powder and solid forms.

The seventh paper by Karimi et al. [A7] calculates the impact of cross-talk on reconstructed image noise and on SNR in radiographs. The noise model, which extends previous work done on cross-talk estimation from autocovariance measurements, was shown to agree with experimental data and simulation data. Additionally, it was demonstrated that cross-talk cannot be disregarded when assessing CT image quality.

We would like to thank all of the authors who contributed their papers to this special section on NDT&E. We would also like to thank the reviewers for their time and constructive feedback, which enhanced the quality of this special section. We also would like to express our sincere appreciation to the Editor-in-Chief, Prof. Shervin Shirmohammadi at the University of Ottawa, and OJIM Administrators Reta Wehmeier and Laura Roach for their support to make this special section publishable.

APPENDIX: RELATED ARTICLES

[A1] J. T. Case and S. Kenderian, "Self-determined shot geometry for open-configuration portable X-ray CT," *IEEE Open J. Instrum. Meas.*, vol. 2, 2023, Art. no. 4500111, doi: 10.1109/OJIM.2023.3268451.

[A2] M. Dvorsky, M. T. A. Qaseer, and R. Zoughi, "Multimodal solution for a circular waveguide radiating into multilayered structures using the axially symmetric modes," *IEEE Open J. Instrum. Meas.*, vol. 2, 2023, Art. no. 8000213, doi: 10.1109/OJIM.2023.3280489.

[A3] Z. Zhang, Z. Chen, J. Xu, and W. Yin, "Improving SNR and sensitivity for low-coupling EMT sensors," *IEEE Open J. Instrum. Meas.*, vol. 2, 2023, Art. no. 4500311, doi: 10.1109/OJIM.2023.3305658.

[A4] A. Gilmour et al., "Using phased array ultrasound to localize probes during the inspection of welds," *IEEE Open J. Instrum. Meas.*, vol. 2, 2023, Art. no. 7500110, doi: 10.1109/OJIM.2023.3327484.
[A5] T. Deleruyelle, A. Auguste, F. Sananes, and G. Oudinet, "Non destructive diagnostic measurement methods for HF RFID devices with AI assistance," *IEEE Open J. Instrum. Meas.*, early access, Nov. 29, 2023, doi: 10.1109/OJIM.2023.3335537.
[A6] A. Case et al., "microwave complex permittivity of yttria-stabilized zirconia," *IEEE Open J. Instrum. Meas.*, vol. 2, 2023, Art. no. 6000105, doi: 10.1109/OJIM.2023.3332398.
[A7] S. Karimi, J. Hall, J. A. Smith, and J. Tringe, "The impact of cross-talk in a flat panel detector on CT image quality," *IEEE Open J. Instrum. Meas.*, early access, Nov. 14, 2023, doi: 10.1109/OJIM.2023.3332342.

KATIE BRINKER
Pratt & Whitney
East Hartford, CT 06118 USA

Reza Zoughi
Iowa State University
Ames, IA 50011 USA