INDIN 2024

Tutorial Proposal

Title of the Proposal: Digital Twin for Predictive Maintenance

- Presenter(s):
Professor Zheng Liu, The University of British Columbia (Okanagan Campus)

- Brief description:
The industry is migrating from reactive to predictive maintenance to increase operational availability and efficiency. An exciting chance to facilitate this transformation is coming with the 4th industrial revolution enabled by new information and communication technology (ICT) and data-intensive methodologies. The digital twin is a disruptive technology that creates a living model of industrial assets. The digital twin living model will continually adapt to changes in the environment or operations using real-time sensory data and forecast the future of the physical target. A digital twin can be used to proactively identify potential issues with its real physical counterpart. It allows the prediction of the remaining useful life of the physical twin by leveraging a combination of physics-based models and data-driven analytics. The digital twin ecosystem comprises sensor and measurement technologies, industrial Internet of Things, simulation and modeling, machine learning, artificial intelligence, and data/information fusion.

The tutorial will address a series of forward-looking topics crucial for harnessing the full potential of digital twin technology in predictive maintenance. These topics include an introduction to digital twins and their role in the 4th industrial revolution, the architectural and operational principles underlying digital twins, and the integration of sensor and measurement technologies with industrial Internet of Things (IoT) frameworks. A significant focus will be on the methodologies for simulating and modeling industrial assets, alongside the application of machine learning and artificial intelligence (AI) for data-driven analytics and prediction. Additionally, the tutorial will delve into data/information fusion techniques that enhance the accuracy and reliability of digital twins. The emphasis on these subjects is highly timely, given the rapid evolution of ICT and the pressing need for industries to improve efficiency, reduce downtime, and anticipate maintenance needs to remain competitive. By exploring these cutting-edge technologies and methodologies, the tutorial will equip participants with the knowledge to navigate the challenges and seize the opportunities presented by digital twin technology in the context of predictive maintenance and beyond.

- Duration:
1 hour

- Outline:

    I.   Introduction
    II.   Predictive maintenance

-Brief CV:

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Zheng Liu (S'99-M'02-SM'06) received a Doctorate in Engineering (measurement and evaluation) from Kyoto University, Japan, in 2000 and a Ph.D. degree (electrical engineering) from the University of Ottawa, Canada, in 2007. From 2000 to 2001, he was a Research Fellow at the Nanyang Technological University, Singapore. Dr. Liu then joined the National Research Council of Canada (Ottawa, Ontario) as a Governmental Laboratory Visiting Fellow nominated by NSERC in 2001. Since 2002, he has become a Research Officer associated with two research institutes of NRC (Aerospace & Construction). From 2012 to 2015, Dr. Liu worked as a Full Professor at Toyota Technological Institute, Nagoya, Japan. He is now with the Faculty of Applied Science at the University of British Columbia. His research interests include predictive maintenance, data/information fusion, computer/machine vision, machine learning, smart sensor and industrial IoT, and non-destructive inspection and evaluation. Dr. Liu is a fellow of SPIE and a senior member of IEEE. He holds a Professional Engineer license in both British Columbia and Ontario. Dr. Liu serves on the editorial boards for journals including IEEE Transactions on Emerging Topics in Computational Intelligence, IEEE Transactions on AgriFood Electronics, Information Fusion, Machine Vision and Applications, and IET/CAAI Transactions on Intelligence Technology.

- Relevant publications:

- R. Rayhana, L. Bai, G. Xiao, M. Liao, and Z. Liu, "Digital twin models: Functions, challenges, and industry applications," *IEEE Journal of Radio Frequency Identification*, pp. 1–30, Apr. 2024, in press.
- T. Wang, K, Feng, J. Ling, M. Liao, C. Yang, R. Neubeck, and Z. Liu, "Pipeline condition monitoring towards digital twin system: A case study," *Journal of Manufacturing Systems*, Feb. 2024, in press.
- Z. Liu, E. Blasch, M. Liao, C. Yang, K. Tsukada, and N. Meyendorf, "Digital twin for predictive maintenance," in *NDE 4.0, Predictive Maintenance, Communication, and Energy Systems: The Digital Transformation of NDE*, Norbert G. Meyendorf, Christopher Niezrecki, and Ripi Singh, Eds., Long Beach, CA, 2023, International Society for Optics and Photonics, vol. 12489, p. 1248907, SPIE
- Z. Liu, N. Meyendorf, and N. Mrad, "The role of data fusion in predictive maintenance using digital twin," in *44th Review of Progress in Quantitative Nondestructive Evaluation, Volume 37*, Dale E. Chimenti and Leonard J. Bond, Eds., vol. 1949, pp. 020023–1–020023–6. American Institute of Physics, Salt Lake City, Utah, USA, July 2017.