Proposal for ISIE 2021 Tutorial

Title of Tutorial:

Digital Twin for Predictive Maintenance

Contact Information of Speakers:

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Background of Speakers:

Zhegn Liu
- Sensor and measurement system
- Data/information fusion
- Industrial inspection

Brief description of the tutorial (500 words max):

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 triggered by new information and communication technology (ICT) and data-intensive methodologies (i.e., artificial intelligence and big data techniques). The Internet of Things (IoT) brings together sensors, cloud computing, and big data analytics and will profoundly transform our society into a digital world. Industrial IoT, also known as IIoT, is the use of IoT technologies in industrial applications where robustness, reliability, and security are highly desired performance requirements for IIoT. The direct economic impact from IIoT is the implementation of predictive maintenance, which will turn the aggregated data and information into actionable decisions for asset maintenance. Predictive maintenance has the capability to determine when maintenance should be performed based on the actual conditions of the structures, components, and sub-systems. Once in

place, predictive maintenance capabilities could eliminate added expenses such as expedited shipping costs for parts or supplies, reduce overtime expenses for crews and, most importantly, lead to fewer unplanned maintenance downtime events.

The digital twin is a disruptive technology that creates a living model of a physical asset for predictive maintenance. The living model will continually adapt to changes in the environment or operation using real-time sensory data and forecast the future of the corresponding physical assets. 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 (RUL) of the physical twin by leveraging a combination of physics-based (physics from first principles) models and data-driven analytics. The digital twin ecosystem comprises the sensor and measurement technologies, industrial Internet of Things, simulation and modeling, and machine learning.

This tutorial will describe the digital twin technology and highlight the computational intelligence for the digital twin ecosystem. The needs for predictive maintenance are identified from a comprehensive literature review. How to apply and implement the digital twin for predictive maintenance will be then introduced. Case studies will be presented in the tutorial to illustrate the process for digital twin development. Finally, the trends for future R&D will be presented.

Biography:

Zheng Liu (S'99-M'02-SM'06) received the Doctorate degree in engineering (earth resources) from Kyoto University, Kyoto, Japan, in 2000, and the Ph.D. degree (electrical engineering) from the University of Ottawa, Canada, in 2007. From 2000 to 2001, he was a Research Fellow with 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. From 2002, he became a Research Officer associated with two research institutes of NRC (Aerospace [IAR] & Construction [IRC]). From 2012 to 2015, he worked as a Full Professor with Toyota Technological Institute, Nagoya, Japan. He is now with the Faculty of Applied Science at the University of British Columbia – Okanagan. 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 is co-chairing the IEEE Instrumentation and Measurement Society technical committee (TC-1). 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 Instrumentation and Measurement, IEEE Transactions on Mechatronics, IEEE Journal of RFID, Information Fusion (Elsevier), Machine Vision and Applications (Springer), Canadian Journal of Electrical and Computer Engineering, Intelligent Industrial Systems (Springer), and IET/CAAI Transactions on Intelligence Technology. He also serves the Standards & Interoperability Committee of the Research Data Canada.

Brief description of the intended audience

The intended audiences are engineers in the industry and researchers in academia for measurement, instrumentation, and asset lifecycle management. Senior undergraduate students and graduate students will also benefit from this tutorial for up-to-date knowledge and possible research ideas.

Support technical committee in IES (if any)

I serve three TCs of IEC:

- Standards Technical Committee
- Sensors and Actuators Committee
- Cloud and Wireless Systems for Industrial Applications Committee

I am asking the support from the committee chair and still waiting for the response.

IEEE/IES Technical committee on XYZ, Name of chair, Email address of chair.