Machine Learning for Additive Manufacturing (ML4AM)

Organizers: Qiang Huang, Zengxi Pan, YuMing Zhang

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Abstract: Quality and productivity are critical for additive manufacturing (AM). With increased availability of AM product data, Machine Learning for AM (ML4AM) has become a viable strategy for knowledge discovery and performance enhancement. This workshop provides tutorial on engineering-informed data analytics framework to facilitate efficient machine learning of AM product data, process monitoring and defect detection for the new wire arc additive manufacturing (WAAM), and deep learning-based monitoring of weld penetration for WAAM application.

Descriptions: The workshop covers the following topics

- The engineering-informed ML4AM will introduce 3D shape accuracy representation; prescriptive modeling of shape accuracy through learning heterogeneous training data; optimal compensation of shape deformation, engineering-informed transfer learning in AM systems; Statistical transfer learning methods and applications in AM (Dr. Q. Huang).
- Process monitoring and defect detection is one of the major challenges for the successful adoption of the WAAM process for wider industrial adoption. The tutorial introduces two recent initial progresses using electrical signals and computer vision to provide prediction of process abnormalities. Machine learning algorithms are the key developments in both cases. (Dr. Z. Pan)
- Monitoring weld penetration is to use measurable signals such as the weld pool images to estimate what occurs underneath the melted materials. Conventional methods hand-crafted features from measured signals. Deep learning provides an effective method to directly correlate the raw signals to the penetration state. Effective right features are automatically extracted. The tutorial analyzes the challenges of the problem, the sufficiency of various raw signals that have been used, and how the raw signals determine deep learning models structures. (Dr. Y. Zhang)

Mode: In-person/Mexico City

Short Bio: Dr. Qiang Huang is currently a Professor at the Daniel J. Epstein Department of Industrial and Systems Engineering, University of Southern California (USC), Los Angeles. His research focuses on AI and Machine Learning for Manufacturing, in particular, Machine Learning for Additive Manufacturing (ML4AM). He was the holder of Gordon S. Marshall Early Career Chair in Engineering at USC from 2012 to 2016. He received IISE Fellow Award, NSF CAREER award, and 2021 IEEE CASE Best Conference Paper Award, 2013 IEEE Transactions on Automation Science and Engineering Best Paper Award, among others. He has five patents on ML4AM. He is a Department Editor for IISE Transactions and an Associate Editor for ASME Transactions, Journal of Manufacturing Science and Engineering.

Dr. Zengxi Pan is an associate Professor of Mechanical Engineering at the University of Wollongong, Australia. In the past 10 years, he is a leading researcher in the Wire Arc Additive Manufacturing, with over 70 papers covering a wide spectrum including programming, path planning, process modelling and control, material study and new alloy development. Dr. Pan is the chair of IIW technical commission XII-A: Sensor and Control for Arc Welding processes and production systems since 2013. He is the associate editor for IEEE robotics and automation letter, IIW Welding in the World journal and Journal of Manufacturing Processes.

Dr. YuMing Zhang is the James R. Boyd Professor of Electrical Engineering at the University of Kentucky where he has conducted research in monitoring and control of welding processes and intelligent robotic welding over 30 years. His research has brought him 12 US patents and over 200 journal papers. Dr. Zhang is a Fellow of the American Welding Society (AWS), ASME, and SME, and has been a senior member of the IEEE since 1996. Dr. Zhang is also a past Chair of the AWS Technical Papers Committee and is currently an Editor for Journal of Manufacturing Processes published by the SME.