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Probabilistic Digital Twins for Diagnosis, Prognosis and Decision-Making

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ABSTRACT: The digital twin paradigm integrates information obtained from sensor data, physics models, as well as operational and inspection/maintenance/repair history of a physical system or component of interest. As more and more data becomes available, the resulting updated model becomes increasingly accurate in predicting future behavior of the system, and can potentially be used to support several objectives, such as sustainment, mission planning, and operational maneuvers. This presentation will discuss recent advances in digital twin methodologies to support all three objectives, based on several types of computations: current state diagnosis, model updating, future state prognosis, and decision-making. All these computations are affected by uncertainty regarding system properties, operational parameters, usage and environment, as well as uncertainties in data and the prediction models. Therefore the presentation will address decision-making under uncertainty, and uncertainty quantification in diagnosis and prognosis, considering both aleatory and epistemic uncertainty sources. Scaling up the probabilistic digital twin methodology to support real-time decision-making is a challenge, and several strategies that combine recent advances in sensing, computing, data fusion and machine learning to enable the scale-up will be discussed. Several use cases related to buildings, aircraft, marine vessels, and additive manufacturing will be presented.

Seminar Details

Friday, March 7, 2025
2:30pm – 4:00pm

UH Campus Classroom & Business Building
Room CBB 108

Online via https://www.cive.uh.edu/research/seminars

BIOGRAPHY: Professor Sankaran Mahadevan has 36 years of research and teaching experience at Vanderbilt University in uncertainty quantification, reliability analysis, machine learning, structural health monitoring, and optimization under uncertainty. His research has been extensively funded by NSF, NASA, FAA, DOE, DOD, DOT, NIST, and the automotive, aerospace, and railroad industries. His research contributions are documented in more than 700 publications, including two books and 350 journal papers. He has directed 56 Ph.D. dissertations and 24 M. S. theses, and has taught many industry short courses on uncertainty quantification and risk and reliability methods. He is a Fellow of AIAA, Engineering Mechanics Institute, and Prognostics & Health Management Society, and has won prestigious awards such as the ASCE Alfredo Ang Award, IASSAR Senior Distinguished Research Award, ASCE George Winter Medal, and the NASA Next Generation Design Tools Award. He was recently President of the ASCE Engineering Mechanics Institute, and managing editor of the ASCE-ASME Journal of Risk and Uncertainty (Part B: Mechanical Engineering). He is currently Chair of the ASME VVUQ Subcommittee on Advanced Manufacturing.