香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

土木及環境工程學系
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

SEMINAR

HIERARCHICAL BAYESIAN INFERENCE FRAMEWORK FOR UNCERTAINTY QUANTIFICATION AND RELIABILITY ASSESSMENT IN STRUCTURAL DYNAMICS

Speaker

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Department of Mechanical Engineering, University of Thessaly, Greece

Abstract

The lecture will focus on presenting recent developments of a Hierarchical Bayesian Modelling (HBM) framework for data-driven uncertainty quantification and propagation in structural dynamics simulations. The HBM framework is based on physics-informed models of dynamical systems and measurements collected during system operation. HBM is introduced to account for the uncertainty due to the experimental, environmental (e.g. temperature), manufacturing and operational (e.g. loading) variabilities as well as variabilities that arise from model error and assembling process. The framework is extended to account for multi-level physics-based modelling of systems and multi-level models of uncertainties using multi-level test data. Accurate approximations based on either asymptotic analyses or a variational inference technique are developed to substantially reduce the computational burden as well as gain valuable insight on the interpretation of the diverse sources of uncertainties. The lecture will cover issues related to the propagation of the data-driven uncertainties in simulations for estimating the uncertainty in response of important quantities of interest and for updating reliability given the monitoring data. Applications of the framework to structural health monitoring will also be discussed. The HBM framework provides a better account for the parameter uncertainties, distinguishing between irreducible and reducible uncertainties. It is demonstrated to be beneficial, particularly for the propagation of uncertainty in data-driven engineering simulations, providing realistic uncertainty bounds to system operation- and safety-related output quantities of interest. Simulated and experimental studies from structural dynamics are used to demonstrate the effectiveness of the proposed framework. The HBM framework is generic and applicable to various disciplines of engineering and science.

Biography

Costas Papadimitriou is Professor in the Department of Mechanical Engineering at the University of Thessaly (UTH). He received his Diploma (1984) in Mechanical Engineering from University of Patras, Greece. He got his MSc (1985) and PhD (1990) in Applied Mechanics from the California Institute of Technology (Caltech). He held the position of the Executive Vice-President of the European Association of Structural Dynamics (EASD) (2011-2017). His research interests include data-driven uncertainty quantification in engineering science; finite element model updating; structural health monitoring; structural reliability. He is the recipient of the 2014 European Association of Structural Dynamics Senior Award in Computational Structural Dynamics. He served/serves as associate editor for the ASCE Journal of Engineering Mechanics (2009-2017); Academic Editor of Structural Control and Health Monitoring (2022-present); member of the editorial board of several international journals; Chair of the Dynamics committee of ASCE-EMI (2012-2014).

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Civil Engineering
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