Department of Structural Engineering
University of California, San Diego

Computational Mechanics Seminar Series

&

SE 290 Structural Engineering Seminar

Professor Wing Kam Liu

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"Self-Consistent Clustering Analysis for Data-Driven Design of Multiscale Material Systems"

Monday, February 27, 2017
12:00 pm - 12:50 pm, SME Building, Room 248

Refreshments served from 11:30am to 12:00pm, SME Building, 2nd Floor Patio

http://structures.ucsd.edu/node/2126

Abstract

The advent of advanced processing and manufacturing techniques provides unparalleled freedom to design new material classes with complex microstructures across scales from nanometers to meters. In this lecture a new data-driven computational framework for the analysis and design of these complex material systems will be presented. A mechanistic concurrent multiscale method called self-consistent clustering analysis (SCA) is developed for general inelastic heterogeneous material systems. The efficiency of SCA is achieved via data compression algorithms which group local microstructures into clusters during the off-line training stage, thereby reducing required computational expense. Its accuracy is guaranteed by introducing a self-consistent method for solving the Lippmann-Schwinger integral equation in the on-line predicting stage. The integration of microstructure reconstruction and subsequent high-fidelity multiscale predictions of the materials behavior leads to the generation of vast amounts of reliable data. This structure-property feedback loop enables the design of new material systems with new capabilities. In mathematical physics, the “structure”

and “property” can be interpreted as the nonlocal interaction of the microstructure clusters and the virtual work at the corresponding material point, respectively. Based on the computational design of experiments, data mining techniques offer the ability to discover the influence of the microstructure on the macroscopic materials behavior. The proposed framework will be illustrated for advanced composites and the integrated design of various advanced material systems.

Biography

Professor Liu is a world leader in multiscale simulation-driven engineering and science. His research has benefitted the understanding and design of nano-materials, engineering material systems and additive manufacturing, biological processes, and the use of organic and inorganic materials for drug delivery systems, bio-sensing, and other diagnostic and therapeutic applications. In 2014, Liu is selected as a *highly cited researcher in Computer Science* and *a member of the World’s Most Influential Scientific Minds* by Thompson Reuters for the period 2002 through 2012. Liu’s selected honors include 2014 JSCES Grand Prize in recognition of outstanding contributions in the field of computational mechanics, the Honorary Professorship from Dalian University of Technology in 2013, the International Association of Computational Mechanics (IACM) Gauss-Newton Medal; the ASME Dedicated Service Award, the Robert Henry Thurston Lecture Award, the Gustus L. Larson Memorial Award, the Pi Tau Sigma Gold Medal and the Melville Medal, (all from ASME); the John von Neumann Medal and the Computational Structural Mechanics Award from the US Association of Computational Mechanics (USACM); and the IACM Computational Mechanics Award, and the Computational Mechanics Award from Japanese Society of Mechanical Engineers. Currently, Liu is the President of IACM, the Chair of the US National Committee of Theoretical and Applied Mechanics (USNCTAM) and a member of the US Board of International Scientific Organizations. Liu chaired the ASME Applied Mechanics Division and is a past president of USACM. He was the founding Director of the NSF Summer Institute on Nano Mechanics, Nano Materials, and Micro/Nano Manufacturing, Founding Chairman of the ASME NanoEngineering Council, and Founding Director of the Master of Science in Simulation-Driven Engineering Program at Northwestern University. He is the editor of two International Journals and honorary editor of two journals and has been a consultant for more than 20 organizations. Liu has written four books; and he is a Fellow of ASME, ASCE, USACM, AAM, and IACM.