IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Computational and Data-Enabled Science and Engineering for Multiphysics Systems

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Seminar on Thursday, March 9, 2017 at 11:00 am in 2004 Black
Seminar host: Ming-Chen Hsu

Abstract

Engineering systems feature unprecedented complexities arising from multiphysics and multiscale, posing critical challenges to the scientific community and industry. Computational and data-enabled science and engineering (CDS&E), recently emerging as a focal point across multidisciplinary fields, including aerospace, energy management, additive manufacturing, and biomedicine, enables major engineering breakthroughs by discovering underlying physics, identifying decisive patterns, and accelerating system developments. A recent trend is to apply CDS&E in essentially each phase of multiphysics system and technology development, from conceptualization, virtual prototyping and design, and automation and control, to final verification and validation.

In this seminar, I will first highlight the significance and impacts of CDS&E to solving practical multiphysics problems. Then main thrust areas and projects of CDS&E research undertaken in my group will be presented, including equation-based and data-driven reduced order modeling, large-scale and/or real-time data analytics and management, and millifluidics-microfluidics system engineering/experimentation. These efforts demonstrate the great promise of CDS&E in system performance assessment, real-time simulation/prediction, design and optimization, control synthesis, and feature detection and signature analysis. The equation-based model order reduction for fast and accurate multiphysics analysis that has recently gained significant attraction from the federal agencies will be further elucidated. Its salient computing performance, i.e., orders of magnitude of speed up with minor errors in contrast to the existing high-fidelity methods will be demonstrated through relevant case studies, such as NASA's X-56A MUTT aeroservoelasticity, MDA's missile hardbody thermal analysis, and thermal cycling in microfluidic PCR chips. The seminar will be concluded with a discussion about the future research of CDS&E with significant opportunities for real-world engineering and "engineering intelligence".

Bio

Dr. **Yi Wang** obtained his B.S. and M.S. in Machinery and Energy Engineering from Shanghai Jiao Tong University, P.R.China in 1998 and 2000, respectively; and his Ph.D. in Mechanical Engineering from the Carnegie Mellon University in 2005. Since 2005, he has held several positions of increasing responsibility at the CFD Research Corporation (CFDRC), Huntsville, Alabama. Currently he is the director of the Advanced Technologies at CFDRC. He has been a principal investigator or a project manager on 26 DoD-, MDA-, NASA-, and NIH-funded projects to develop advanced methodologies and techniques in computational and data-enabled science and engineering (CDS&E), including reduced order modeling, data reduction, large-scale and/or real-time data analytics, hierarchical system-level simulation, and system engineering. The applications of these technologies span spacecraft and missile thermal analysis, aeroservoelasticity and aerothermoservoelasticity, massive computational data management, real-time flight load data processing, integrated multi-scale fluidics systems (design, fabrication, and experimentation) for environmental monitoring, biodefense, and regenerative medicine. He has coauthored 4 book chapters, 33 journal papers, and 44 conference proceeding papers and abstracts. He is also the co-inventor of 5 patents/patent applications.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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