SIBLEY SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING COLLOQUIUM SERIES

"Challenges and Methods for the Integrated Design of the Architecture, Plant, and Control of Dynamic Engineering Systems"

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Refreshments at 3:30, 116 Upson Hall

ABSTRACT

Using fully integrated design methods facilitates the discovery of fundamentally new solutions and identification of system performance limits but is a challenging endeavor for dynamic engineering systems. Many critical design decisions can be broadly characterized as either architecture, plant, or control decisions. Effectively exploring the design flexibility in these areas demands design automation theory and tools that support such considerable scope and complexity.

In this talk, we will discuss significant recent developments in solving these combined design problems contextualized through a variety of case studies. First, we will discuss the concept of co-design (or combined plant and control design) and a design study for the structural dynamics and distributed control of a strain-actuated solar array system for reorienting spacecraft. Next, graph-based representations and enumeration algorithms that facilitate the exploration of new architectures will be presented. A number of case studies that utilize the enumerative methods will be presented including aircraft thermal management systems, single-split fluid-based cooling architectures, vehicle suspensions, and electric circuits. These various case studies have unique challenges and structure that must be analyzed in order to develop efficient solution strategies such as network structure constraints, automated model creation, and optimization problem structure. The electric circuit design study will provide a rich discussion on comparisons to existing approaches based on evolutionary computing and the use of machine learning to generate new architectures and reduce evaluation cost.

Parts of this talk are joint efforts with Dr. James Allison (UIUC), NSF Engineering Research Center for Power Optimization for Electro-Thermal Systems (POETS-UIUC), Jet Propulsion Laboratory (JPL), and Air Force Research Laboratory (AFRL).

BIOGRAPHICAL SKETCH

Dr. Daniel Herber is a postdoctoral research associate with the NSF Engineering Research Center for Power Optimization for Electro-Thermal Systems (POETS) at the University of Illinois at Urbana-Champaign (UIUC). He received a B.S. in General Engineering (2011) and an M.S. (2014) and a Ph.D. (2017) in Systems and Entrepreneurial Engineering from UIUC. His research interests include systems engineering, architecture synthesis, graph enumeration, design optimization, combined plant and control design (co-design), and numerical methods for optimal control concentrated around the development of novel theory and tools for integrated design methods for dynamic systems. His work has made fundamental contributions to a variety of engineering applications including the design of strain-actuated solar arrays for reorienting spacecraft, thermal management networks for aircraft, wave energy converters, active vehicle suspensions, and passive electrical circuits.