PennState College of Engineering

Systems, Controls, and Robotics Seminar Series

Architectural Thermofluid Systems: Next-Generation Challenges and Opportunities in Control, Estimation, and Machine Learning

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ABSTRACT

Buildings and their constituent systems are widely expected to play an important role in solutions to many pressing energy and climate challenges, as they consume 40% of the energy in the U.S. and can contribute to emerging trends of electrification and decarbonization. Because these common systems-of-systems exhibit complex multiphysical behavior, rigorous and robust approaches to system modeling, design, and operation are essential if building systems are to evolve to meet future requirements via such technology as digital twins and model predictive controls.

In this talk, I will first describe some aspects of these systems, as represented by sets of differential-algebraic equations, which present distinct challenges when applying conventional control design and estimation methods. I will then review new equation-oriented modeling tools in Modelica and Julia that are well-suited to addressing large-scale problems with these nonlinear characteristics, and survey some recent results in applying control design, estimation, and machine learning approaches to achieve appreciable performance benefits. The talk will conclude with a brief discussion of promising directions for future research and investigation.

BIOGRAPHY

Christopher Laughman received the S.B. (1999) and M.Eng. (2001) degrees in Electrical Engineering and Computer Science, as well as the Ph.D. (2008) degree in Architecture, from the Massachusetts Institute of Technology. He has been with Mitsubishi Electric Research Laboratories since 2008, where he currently holds the position of Senior Principal Research Scientist and is the Senior Team Leader of the Multiphysical Systems team. His research interests include the modeling, simulation, control, and optimization of large-scale multiphysical systems, with an emphasis on multiphase thermofluid applications. He is a member of ASHRAE and is also a member of the board of the North American Modelica Users' Group.