SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

Numerical Methods for Nonlinear Optimal Control Problems and Their Applications in Indoor Climate

DISSERTATION DEFENSE
By

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Abstract: Efficiency, comfort, and convenience are three major aspects in the design of control systems for residential Heating, Ventilation, and Air Conditioning (HVAC) units. However, current solutions for indoor climate control focus on concentrated models, which lack the detail to fully model the energy consumed in air convection or to describe the thermal comfort of the residents.

In this talk we present our results on distributed-model based optimal control strategies for HVAC systems. Our formulation uses a Computer Fluid Dynamics (CFD) model, which is mathematically formulated by nonlinear partial differential equations, to describe the interactions between temperature, pressure, and air flow. Due to the complexity of the PDE-constrained optimal control problem, we develop several optimization-based numerical algorithms, each applicable to different scenarios, such as improving the energy efficiency of HVAC system by maintaining temperature inside a small target region around resident, developing an estimation algorithm to reconstruct indoor climate distribution and doors configuration by only thermostats, developing a model predictive control to directly maintain indoor residential thermal comfort.

Due to our dependence on distributed-parameter models, our algorithms for the control of HVAC systems result in large-scale numerical optimization problems. In order to balance the accuracy of the optimal solution and computation complexity, we develop a new sampling-based numerical algorithm. This algorithm reduces the computational effort when solving optimal control problems by approximating the dynamical vector field as a convex cone. This approximation allows us to solve a sequence of convex optimization problems in parallel, even for constrained nonlinear problems. Moreover, we show the consistency of our algorithm, as local minimizers converge to local minimizers of the original infinite-dimensional optimal control problem. We validate the algorithm via simulations, the results open the doors to potentially solve nonlinear PDE-constrained optimal control in real time.

DATE: **Monday, June 19, 2017**
TIME: **3:00 p.m.**
PLACE: **Green Hall, Room 0120**

Dissertation advisor:
Dr. Humberto Gonzalez

This seminar is in partial fulfillment of the Doctor of Philosophy degree

Washington University in St. Louis
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