

Optimal Control of Switching/Hybrid Systems with Applications to Hybrid Electric Vehicles, Dc-Dc Converters, and Autonomous Mobile Robots

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This workshop will present recently developed results on the solution of the hybrid/switched optimal control problem using the embedding method developed by Bengea and DeCarlo (Automatica, January 2005). Using a variation of the collocation method, a numerical solution of the problem via sequential quadratic programming is outlined. Using these tools and a model predictive control approach, application of the techniques to the switching control of a boost converter using a sliding mode observer is then presented followed by the model predictive control of mobile robots and groups of autonomous aerial vehicles (AUVs). Finally, a solution to the power management problem in a hybrid electric vehicle is presented with simulation studies for a variety of driving profiles including the new EPA driving profile. The examples will not only describe appropriate models, MPC control methodologies, and simulation studies, but also highlight the broader appeal of these newly developed techniques for modeling, analysis, and design of hybrid/switched systems.

SCHEDULE: SEPTEMBER 2, 2008

- 08:00-9:15 The Embedding Approach to Switched/Hybrid Optimal Control
- Problem Statement
 - Embedding Formulation
 - Relations Between the Original and the Embedded Problems
 - Existence and Uniqueness Results
 - Miscellaneous results and techniques
- 09:25-10:30 Numerical Solution of the Switched/Hybrid Optimal Control Problem
- Collocation
 - Choice of Basis Functions
 - Numerical Optimization
- 10:30-10:45 Break/Refreshments
- 10:45-12:0 Switching Control of a Boost Converter
- Lossy Model of Converter
 - MP Switching Control & Performance Measure
 - Sliding Mode Observer
 - Simulation/Hardware Studies and Comparison to Traditional Control Techniques
- 13:00-13:50 Control of Unicycle/Autonomous Mobile Robots
- Switching Behavior in Wheeled Vehicles
 - Traction and Propulsion Control of Wheeled Vehicles
 - Coordination Control of Unmanned Aerial Vehicles
- 14:00-15:00 Application to Hybrid Electric Vehicles
- Power Flow Modeling
- 15:00-15:15 Break/Refreshments
- 15:15-16:30 Application to Hybrid Electric Vehicles Continued
- Switched Optimal and Suboptimal MPC Strategies
 - Simulation Studies

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