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Numerical Methods for Fast Optimal Control of Mechatronic Systems

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Abstract:

In the last 15 years computation times of real-time algorithms for nonlinear model predictive control have decreased by a factor of 100 000. This tremendous speed-up is not only due to faster computer hardware, but also due to algorithm development and novel software implementations. In this talk we review these algorithmic and software developments of numerical methods for real-time model predictive control. We demonstrate that nowadays receding horizon control problems with 20-30 states and several time-varying control variables can be solved within a few milliseconds. This allows us to apply nonlinear real-time optimal control to challenging applications such as mechatronic systems with fast sampling times. We present the software environment ACADO Toolkit as well as its extensions towards automatic code generation. It features an optimal control code that is based on a real-time variant of a multiple-shooting based Gauss-Newton method. The nonlinear feedback control algorithm and its potential will be illustrated with challenging real-world applications including the control of fast flying tethered airplanes for wind power generation. We conclude the talk with a vision of future research directions in real-time optimal control touching the fields of robust and global optimal control algorithms which have the potential to experience a similar speed-up in the coming 15 years.

Biography:

Dr. Boris Houska received his PhD degree from Optimization in Engineering Center (OPTEC). He is member of Dynamic and Embedded Optimization (WG1) and Parameter and State Estimation (WG3). And his research interests include Robust Optimization of Dynamic Systems, Periodic Systems and Stability Optimization, Software for Automatic Control and Dynamic Optimization etc. For more information about his academic achievements, please visit http://www.kuleuven.be/optec/people/25-Dr-Boris-Houska.