Towards Real-time Optimization for PDEs

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Abstract: Closed-loop feedback control constitutes a widely used approach to treat uncertainties in time-dependent problems that allow for repeated measurements. We describe an extension of the Real-Time Iteration (RTI) scheme for Nonlinear Model Predictive Control (NMPC) of ordinary differential equations (ODEs) to the case of parabolic partial differential equations (PDEs). Our work is based on a two-grid Newton-Picard decomposition approach. The extension can be analyzed and implemented as an additional level in the well-known Multi-Level Iteration.

Via Moving Horizon Estimation (MHE) we can obtain the data for an NMPC problem on a finite time horizon of the future. In each iteration an optimal control is determined which we then apply to the system and update repeatedly when new measurements become available. The main challenge is to solve the coupled MHE-NMPC problem in real-time and to reduce the feedback delay between measurement arrival and control update to a minimum.

In this talk we show how to efficiently apply a Newton-Picard approach with two spatial grids and how to split operations into preparation and feedback phase in order to reduce the feedback delay considerably. Furthermore, we will show first numerical results for our approach.

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