

Real-Time Computation of Closed-Loop Controls

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Abstract: The paper reports on recent progress in the real-time computation of constrained closed-loop optimal control, in particular the special case of nonlinear model predictive control, of large DAE systems arising e.g. from semi-discretization of instationary PDE. Through a combination of, among others, a direct multiple shooting approach, a constrained Gauss-Newton method and an operation point embedding, a so-called “real-time iteration” approach has been developed in the last few years. One of the basic features is that in each iteration of the optimization process, new process data are being used. Through precomputation - as far as possible - of Hessian gradients and QP factorizations the response time to perturbations of states and systems parameters is minimized. In real experiments for a distillation column the new approach has been shown to be orders of magnitude faster than previous approaches based on application of off-line optimization methods. For the special class of NMPC problems to guarantee globally stable closed-loop controls, also the new approximate scheme is shown to be nominally stable. It is also shown how the approach can be further drastically accelerated by special algorithmic schemes for on-line feasibility and optimality improvement.

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