Plant-wide MPC: A Cooperative Decentralized Approach

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Abstract

Model predictive control (MPC) technology has seen remarkable development since its first appearance. Due to its success in industrial practice, efforts to extend its application from unit-wide to plant-wide control are becoming more widespread. Centralized or monolithic MPC schemes are impractical, and often impossible, for large-scale, plant-wide applications due to reliability, maintainability and computational tractability considerations. In general, industrial practice has tended toward a distributed MPC architecture; however, this common decentralized approach has been shown to produce lower performance than a centralized approach. In our work we propose to adopt the decentralized approach, but to coordinate the individual MPC systems; thereby, garnering the performance advantages of the centralized approach and the reliability, maintainability and computational efficiency of the distributed MPC schemes. A further benefit of the proposed approach is that it requires far less capital investment to gain equal performance increases, in comparison to implementation of a new centralized, plant-wide MPC.

In this work, we focus on the steady-state target calculation layer within an MPC application. We draw on the Dantzig-Wolfe decomposition principle in conjunction with a multi-column generation strategy to yield a coordinating structure for the decentralized MPC that realizes an effective trade-off between centralized and decentralized MPC target calculation methods. Our approach provides comparable performance to the centralized scheme, while retaining all the benefits of the decentralized approach. In this paper, we discuss methods of constructing information flow between the coordinator and the individual MPC systems, which effectively deal with constraints that span multiple units.

To illustrate our approach, we use case studies to compare the performance of all three control schemes (*i.e.*, centralized, decentralized and coordinated). The results show that the proposed coordination mechanism significantly improves the performance of the overall decentralized control system.