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Author: Mohammad Zamry Jamaludin Christopher L.E. Swartz



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Approximation of Closed-loop Prediction for Dynamic Real-time Optimization Calculations [☆]

Mohammad Zamry Jamaludin, Christopher L.E. Swartz*

Department of Chemical Engineering, McMaster University, 1280 Main St. West, Hamilton L8S 4L7, ON, Canada

Abstract

Dynamic real-time optimization (DRTO) is an extension of the traditional steady-state RTO paradigm to account for process dynamics in the RTO calculations. This paper presents methods for approximating closed-loop dynamic predictions within DRTO calculations for processes regulated under constrained model predictive control (MPC). Three approximation approaches are formulated and analyzed - hybrid, bilevel and input clipping formulations. The hybrid formulation involves application of rigorous closed-loop prediction over a limited DRTO horizon, followed by open-loop optimal control. In the bilevel formulation, only a single MPC optimization subproblem is embedded, whereas the input clipping approach is formulated using an unconstrained MPC algorithm with an input saturation mechanism applied over the DRTO horizon. The relative performance of the proposed approximation approaches is illustrated through two case study applications, the second of which involves economically optimal polymer grade transitions. Excellent closed-loop approximation is achieved without significant loss of prediction accuracy.

Keywords: dynamic real-time optimization, DRTO, closed-loop prediction, complementarity constraints, MPC

1. Introduction

Competitive global market conditions and demand-driven production are characteristics of the present day environment in which industries operate. Consequently, engineers confront a challenging task in operating production plants in a cost-optimal fashion while satisfying the prevailing constraints. Plant economic optimization has been conventionally addressed via a steady-state, real-time optimization (RTO) systems (Marlin and Hrymak, 1997; Darby

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*Corresponding author

Email address: swartzc@mcmaster.ca (Christopher L.E. Swartz)

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