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A parallel structure exploiting nonlinear programming algorithm for multiperiod dynamic optimization

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Abstract

This article develops a sequential quadratic programming (SQP) algorithm that utilizes a parallel interior-point method (IPM) for the QP subproblems. Our approach is able to efficiently decompose and solve large-scale multiperiod nonlinear programming (NLP) formulations with embedded dynamic model representations, through the use of an explicit Schur-complement decomposition within the IPM. The algorithm implementation makes use of a computing environment that uses the parallel distributed computing message passing interface (MPI) and specialized vector-matrix class representations, as implemented in the third-party software package, `OOPS`. The proposed approach is assessed, with a focus on computational speedup, using several benchmark examples involving applications of parameter estimation and design under uncertainty which utilize static and dynamic models. Results indicate significant improvements in the NLP solution speedup when moving from a serial full-space direct factorization approach, to a serial Schur-complement decomposition, to a parallelized Schur-complement decomposition for the primal-dual linear system solution within the IPM.

Keywords: multiperiod dynamic optimization, multiple-shooting, sequential quadratic programming, interior-point methods, parallel computing

1. Introduction

Higher operating costs and shrinking profit margins in the chemical and petro-chemical industries are driving greater applications of advanced control techniques and even further consideration of control at the process design stage. These applications are often model-based

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