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1 A parallel structure exploiting nonlinear programming algorithm for
2 multiperiod dynamic optimization

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6 **Abstract**

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

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

23 **1. Introduction**

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

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