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An efficient parallel coordination method for decomposition-based optimization using two duality theorems

Meng Xu[1], Georges Fadel[1], Margaret M. Wiecek[2], Paolo Guarneri[3]

[1] Clemson University, Department of Mechanical Engineering, Clemson, SC, USA, {xu7, fgeorge}@clemson.edu;
[2] Clemson University, Department of Mathematical Science, Clemson, SC, USA, wmalgor@clemson.edu;
[3] Technical University of Cluj-Napoca, Department of Electrical Machines and Drives, Cluj-Napoca, Romamia, paolo.guarneri@emd.utcluj.ro;

Abstract

In decomposition-based optimization, coordination of sub-problems always plays an important role because it eliminates the inconsistencies between the decomposed sub-problems and drives their solutions towards the optimal solution of the original problem. Coordination is often carried out in an iterative manner and efficiency becomes a critical issue during this process as the complexity of engineering problems continues to grow rapidly. This growing complexity increases the computational cost of iterations and thus parallel coordination methods are preferred over non-parallel methods in many cases. In this paper, based on the Alternating Direction Method of Multipliers (ADMM), a new parallel coordination method with a high efficiency is proposed. Unlike other popular coordination methods in the literature which use duality theorems just once, the proposed method uses duality theorems twice. Specifically, the ordinary duality theorem is applied initially to the original problem to generate a dual problem and then the ADMM is applied to the dual problem. The resulting method requires fewer copies of shared variables for the decomposition, which decreases the coordination effort necessary for the optimization to converge. Numerical tests are conducted on one mathematical and one engineering problem and the results show an increase in efficiency and accuracy for the new method when compared to the centralized Augmented Lagrangian Coordination (ALC), which is one of the most popular parallel coordination methods. Additionally, this increase in performance is consistently displayed by the new method when solving a multimodal structural optimization problem repeatedly starting from different random initial designs, while the centralized ALC fails to show similar robustness.

Keywords: Decomposition-based optimization, ADMM, ALC, duality theorem.