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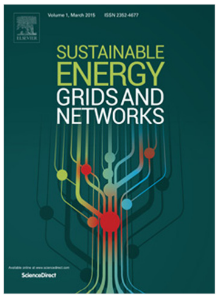

Component-based dual decomposition methods for the OPF problem

Sleiman Mhanna, Archie C. Chapman, Gregor Verbič

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Title: Component-Based Dual Decomposition Methods for the OPF Problem

Abstract: Up to this day, most optimization and control algorithms in power systems, such as the optimal power flow (OPF), are computed in a centralized fashion. With the increasing penetration of distributed energy resources however, the feasibility of the centralized computation paradigm is at stake. Against this backdrop, this paper proposes and compares four different component-based dual decomposition methods for the nonconvex alternating current (AC) OPF problem, where the modified dual function is solved in a distributed fashion. The main contribution of this work is that it demonstrates that a distributed method with carefully tuned parameters can converge to globally optimal solutions despite the inherent non-convexity of the problem and the absence of theoretical guarantees of convergence. This paper is also the first to conduct extensive numerical analysis resulting in the identification and tabulation of the algorithmic parameter settings that are crucial for the convergence of the methods on 76 AC OPF test instances. The scalability of component-based dual decomposition is demonstrated on real-world test systems with more than 13600 buses. Moreover, this work provides a deeper insight into the geometry of the modified Lagrange dual function of the OPF problem and highlights the conditions that make this function differentiable. This numerical demonstration of convergence coupled with the scalability and the privacy preserving nature of the proposed method makes it well suited for smart grid applications such as multi-period OPF with demand response (DR) and security constrained unit commitment (SCUC) with contingency constraints and multiple transmission system operators (TSOs).

Keywords: Optimal power flow; distributed methods; component-based dual decomposition; Augmented Lagrangian relaxation; ADMM; smoothing methods.

Author 1 (Corresponding author):
Name: Sleiman Mhanna
Email: sleiman.mhanna@sydney.edu.au
Mobile phone number: +61410788902
Affiliation: Electrical and Information Engineering, University of Sydney

Author 2:
Name: Archie Chapman
Email: archie.chapman@sydney.edu.au
Affiliation: Electrical and Information Engineering, University of Sydney

Author 3:
Name: Gregor Verbič
Email: Gregor.verbic@sydney.edu.au
Affiliation: Electrical and Information Engineering, University of Sydney

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