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Worst-Case Load Shedding in Electric Power Networks

Authors : Fu Lin

Abstract : We consider the worst-case load-shedding problem in electric power networks where a number of transmission lines are to be taken out of service. The objective is to identify a prespecified number of line outages that lead to the maximum interruption of power generation and load at the transmission level, subject to the active power-flow model, the load and generation capacity of the buses, and the phase-angle limit across the transmission lines. For this nonlinear model with binary constraints, we show that all decision variables are separable except for the nonlinear power-flow equations. We develop an iterative decomposition algorithm, which converts the worst-case load shedding problem into a sequence of small subproblems. We show that the subproblems are either convex problems that can be solved efficiently or nonconvex problems that have closed-form solutions. Consequently, our approach is scalable for large networks. Furthermore, we prove the convergence of our algorithm to a critical point, and the objective value is guaranteed to decrease throughout the iterations. Numerical experiments with IEEE test cases demonstrate the effectiveness of the developed approach.

Keywords : load shedding, power system, proximal alternating linearization method, vulnerability analysis
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