Model Predictive Control for Distributed Microgrid Battery Energy Storage Systems

This brief proposes a new convex model predictive control (MPC) strategy for dynamic optimal power flow between battery energy storage (ES) systems distributed in an ac microgrid. The proposed control strategy uses a new problem formulation, based on a linear $d$ – $q$ reference frame voltage-current model and linearized power flow approximations. This allows the optimal power flows to be solved as a convex optimization problem, for which fast and robust solvers exist. The proposed method does not assume that real and reactive power flows are decoupled, allowing line losses, voltage constraints, and converter current constraints to be addressed. In addition, nonlinear variations in the charge and discharge efficiencies of lithium ion batteries are analyzed and included in the control strategy. Real-time digital simulations were carried out for an islanded microgrid based on the IEEE 13 bus prototypical feeder, with distributed battery ES systems and intermittent photovoltaic generation. It is shown that the proposed control strategy approaches the performance of a strategy based on nonconvex optimization, while reducing the required computation time by a factor of 1000, making it suitable for a real-time MPC implementation.

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