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A model predictive control method for hybrid energy storage systems

In this project, the traditional PI controller for a hybrid energy storage system (HESS) has certain drawbacks, such as difficult tuning of the controller parameters and the additional filters to allocate high- and low- frequency power fluctuations. This paper proposes a model predictive control (MPC) method to control three-level bidirectional DC/DC converters for grid-connections to a HESS in a DC microgrid. First, the mathematical model of a HESS consisting of a battery and ultra-capacitor (UC) is established and the neutral point voltage imbalance of a three level converter is solved by analyzing the operating modes of the converter. Secondly, for the control of the grid-connected converters, an MPC method is proposed for calculating steady state reference values in the outer layer and the dynamic rolling optimization in the inner layer. The outer layer ensures the voltage regulation and establishes the current predictive model, while the inner layer, using the model predictive current control, makes the current follow the predictive value, thus reducing the system current ripple. This cascaded topology has two independent controllers and is free of filters to realize the high-and low frequency power allocation for a HESS. Therefore, it allows two types of energy storage devices to independently regulate the voltage and realizes the power allocation of the battery and UC. Finally, simulation studies are conducted in Matlab/Simulink software, and the effectiveness of the proposed HESS control strategy is verified in a case, such as a controller comparison and fault scenario.

Domain: Power Systems _ Hybrid Systems
Technology: Electrical