State-of-Charge Estimation of Lithium-ion Battery Based on Capacity Degradation Model Considering the Dynamic Currents and Temperatures

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The current and temperature are two important factors that influence the performance of lithium-ion batteries. An improved battery model considering dynamic currents and various temperatures is proposed and then applied to battery modeling and state-of-charge (SOC) estimation. A novel capacity model is also employed to reflect real-time capacity degradation. The battery parameter dependencies on current, temperature, and SOC are constructed with a novel semi-empirical approach that combines hundreds of data points obtained from enhanced multiple hybrid pulse power characterization (EMHPPC) tests with the derivation of the Arrhenius equation and the Current-overpotential equation. Finally, the proposed model integrating the unscented Kalman filter (UKF) is employed to estimate the battery SOC. The verification results indicate that the improved method can significantly improve the accuracy of both battery modeling and SOC estimation for broad ranges of current rates and temperatures.

Keywords: Lithium-ion battery; State-of charge; Capacity degradation; Current dependency; Unscented Kalman filter; Electric vehicles.

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