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Performance Analysis of Extended and Sigma-Point Kalman Filter for State-of-Charge Estimation for Battery Management System

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Abstract: *Lithium-ion batteries are state-of-the-art energy storage technology. Instead of having remarkable features, a highly accurate, reliable, and cost-effective battery monitoring technology should continuously monitor the battery cell parameters and ensure the parameters are within the safe operating area recommended by the manufacturer. Precise estimation of SOC is always needed to ensure the safety and longevity of each lithium-ion cell in a battery pack affected by frequent charge and discharge processes. Algorithms based on Kalman filter recursive state estimation are robust to initial SOC uncertainties and sensor noise. Since the internal electrochemical kinetics of the Li-Ion cells are highly complex and non-linear, the Kalman filer non-linear variants such as EKF and SPKF perform exceptionally well in the presence of uncertainties in the initial SOC estimates and sensor measurements. This paper evaluates the robustness of EKF and CDKF regarding state of charge (SOC) estimation accuracy against unknown initial SOC and random sensor noise. The algorithms are implemented in the GNU Octave environment. The experiment results show that SPKF slightly outperforms EKF in terms of rms values. Both EKF and SPKF demonstrate strong robustness against current noise*

Keywords: cell balancing, safe operating zone, state estimation, state-of-charge, state observer, robustness

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