Int. J. Electrochem. Sci., 17 **(2022)** Article Number: 220218, doi: 10.20964/2022.02.18

International Journal of
ELECTROCHEMICAL
SCIENCE
www.electrochemsci.org

A Variable-length scale Parameter Dependent State of Charge Estimation of Lithium Ion Batteries by Kalman Filters

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Received: 4 October 2021 / *Accepted:* 29 November 2021 / *Published:* 5 January 2022

This paper proposes a new state of charge (SOC) estimation algorithm based on Kalman filters (KF). In the first stage, the equivalent circuit model's parameters are estimated by a least square estimation window-wise, assuming a linear SOC and open-circuit voltage (OCV) relation. The algorithm accurately estimates the parameters and observes the changes that depend on SOC. Moreover, based on the estimated parameters, the OCV values are identified. In the next stage, window-wise Kalman filter(ES-KF) without hysteresis voltage and extended Kalman filter (ES-EKF) and sigma-point Kalman filter (ES-SPKF) algorithm with hysteresis voltage are executed to estimate SOC. Having fewer state equations and hysteresis parameters tuned up, the ES-EKF and ES-SPKF perform accurately and improve the results of previous algorithms. The proposed methods are validated by experiments with three different datasets obtained from lab tests. We also show SOC-OCV curve can be obtained in a simple way that replaces the time-consuming C/30 tests.

Keywords: Parameter estimation, State of charge, Battery, Kalman filter, Battery management system

FULL TEXT