CEE691 Graduate Seminars in Civil and Environmental Engineering

Adaptive State of Charge Estimation for Battery Packs

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About the speaker: Dr. Saeed Sepasi joined the Hawaii Natural Energy Institute (HNEI) in 2015 as a postdoctoral scholar. He received his Ph.D. in Mechanical Engineering from the University of Hawaii in 2014. Saeed was a Research Assistant with the Mechanical Engineering Department from 2011 to 2014, during which he developed adaptive methods for estimation of state of charge and state of health for battery packs, specifically Li-ion batteries, and jointly developed control algorithms for a grid-scale energy storage system deployed on the Maui Electric Company power system. Prior to pursuing his doctoral degree, he designed electronic control boards for home appliances from 2009 to 2011 as a quality engineer. His current research interests include optimization of energy storage in smart grids, renewable energy, large-scale renewable power integration into power grids and sustainability.

Abstract

Rechargeable batteries as an energy source in electric vehicles (EVs), hybrid electric vehicles (HEVs) and smart grids are receiving more attention with the worldwide demand for greenhouse reduction. In all of these applications, the battery management system needs to have an accurate online estimation of the state of charge (SOC) of the battery pack. This estimation is difficult, especially after substantial aging of batteries. In order to overcome this problem, this work addresses SOC estimation of Li-ion battery packs using fuzzy- improved extended Kalman filter (fuzzy- IEKF) from new to aged cells. In the proposed approach, a fuzzy method with a new class of membership function has been introduced and used to make the approximate initial value to estimate SOC. Later on, the IEKF method, considering the unit single model for the battery pack, is applied to estimate the SOC for the long working time of the pack. This approach uses a model adaptive algorithm to update each single cell's model in the battery pack. The algorithm's fast response and low computational burden, makes on-board estimation practical. A $LiFePO_4$ single cell/battery pack consists of single/120 cells connected in series with a nominal voltage 3.6V/432 V is used to implement the experiments/simulations to verify the SOC estimation method's accuracy. The obtained results by the federal test procedure (FTP75) and the new European driving cycle (NEDC) reveal that the proposed approach's SOC and voltage estimation error do not exceed 1.5%.