Lithium-ion Battery State of Energy Estimation Using Deep Neural Network and Support Vector Regression

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Abstract:

For the advancement of an effective energy management system for an electric vehicle (EV) application, it is constantly needed to utilize a precise battery state of energy (SOE) estimation method. In this study, two different data- driven SOE estimation methods using deep neural network (DNN) and support vector regression (SVR) are compared. The electric vehicle drive cycles dataset is utilized for training, validation, and testing. Three drive cycle data sets such as DST, FUDS, US06 are utilized for training and validation. Whereas, the WLTP drive cycle is considered for testing. The optimum hyperparameters are obtained by gradient search CV optimization method for both DNN and SVR. Two different testing datasets (e.g., known, and unknown) are considered for the evaluation of SOE estimation using the DNN and SVR models. The SOE estimation results demonstrated the high accuracy of DNN over SVR under the same dynamic operating conditions. For WLTP drive cycle datasets, the recorded value of the estimated SOE RMSE using DNN and SVR are 2.0527

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and 9.0688, respectively. The value of the estimated SOE MAE using DNN and SVR are 0.00421 and 0.0822, respectively.

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Contents

The energy storage system (ESS) in Electric vehicles (EV) plays a significant role to decide the overall performance. The Lithium-ion battery (LIB) with high energy/power density, long cycle life, and high charge/discharge C-rate makes it a more reasonable type of energy storage system for EV [1]. However, an efficient battery management system (BMS) is always required to control and monitor the functioning of LIBs [2]. Some of the key functions of BMS are data acquisition, cell balancing, thermal management, and battery state estimation. As the direct measurement of the battery states is not possible by using a direct measuring device. The estimation algorithms are used for battery state estimation. Different battery states are utilized to perform different functions. There are four different battery states as the state of charge (SOC) [3], state of energy (SOE) [3], state of power (SOP) [4], and state of health (SOH) [5] are utilized in BMS. For example, with the utilization of an accurate SOC estimation method in BMS, the LIBs can be protected from malfunctioning by controlling the charge/discharge rate, overcharging, and deep discharging [6].

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