

Lithium-Ion Battery State of Charge Estimation with Adaptability to Changing Conditions

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Accurate state of charge (SOC) estimation provides critical information to ensure the safe operation of lithiumion batteries (LIBs). With the evolution of artificial intelligence, the model-free deep learning-based SOC estimation has made extraordinary progress. However, collecting sufficient data to train an accurate SOC estimator of batteries' whole lifecycle is costly, and generalizing the estimator to different operating conditions is challenging. To this end, aiming to enhance the generalization ability of data-driven SOC estimators, this paper proposes a novel SOC estimation framework based on adversarial transfer learning (TL), which transfers a well-trained SOC estimator with fewer data demands to fit different conditions. Specifically, a source SOC estimator is trained under a specific condition to learn the basic characteristics of the battery, which is defined as the source domain. Target domains correspond to measured data of the battery under different conditions. An adversarial TL-based training framework is developed to extract the domain invariants of the source and target domains, which is guided by minimizing the distribution discrepancies. The effectiveness of the proposed method is demonstrated through the use of two LIBs datasets. The successful generalization to multiple operating conditions and aging health states demonstrates the estimation accuracy, robustness, and good generalization.