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电池及充电技术

基于子种群自适应思维进化-BP神经网络的锂离子电池SOC估计

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State-of-charge Estimation of Lithium-ion Battery Based on Subpopulation Adaptive Mind Evolutionary Algorithm- BP Neural Network

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摘要

荷电状态SOC (state of charge)是锂离子电池的重要参数之一,SOC的精准估计对电池组安全可靠运行具有重要意义。针对误差反向传播BP (back propagation)神经网络易收敛至局部最优,导致基于BP网络的SOC估计精度不高的问题,提出子种群自适应趋同策略改进思维进化算法,用其优化BP神经网络的初始权值及阈值,优化后的BP网络简称SAMEA-BP神经网络。结合充放电实验数据,将SAMEA-BP神经网络与标准BP神经网络、思维进化算法优化的BP (MEA-BP)神经网络用于锂离子电池的SOC估计,并对3种方法做了对比分析。结果表明:标准BP神经网络的预测误差保持在9%以内,MEA-BP及SAMEA-BP神经网络分别将误差降低至5%及3%以内,在不同工况下和不同温度下,SAMEA-BP有良好适应性,且估计精度高于BP和MEA-BP。

Abstract

State-of-charge(SOC) is one of the important parameters of lithium-ion batteries, and its accurate estimation is of significance for the safe and reliable operation of battery packs. Back propagation(BP) neural network easily converges to the local optimum, which leads to the low accuracy of SOC estimation based on BP network. To solve this problem, a subpopulation adaptive convergence strategy is proposed in this paper to improve the mind evolution algorithm, which is further used to optimize the initial weights and thresholds of BP neural network. After optimization, the BP network is abbreviated as SAMEA-BP. Combined with the experimental data of charging and discharging, the proposed SAMEA-BP, BP, and BP neural network optimized by mind evolution algorithm(MEA-BP) are used to estimate the SOC of lithium-ion batteries, and the three methods are compared and analyzed. Results show that the prediction error of the standard BP neural network remains within 9%, and the MEA-BP and SAMEA-BP neural networks reduce the error to within 5% and 3%, respectively. Under different working conditions and different temperatures, SAMEA-BP has a good adaptability, and its estimation accuracy is higher than those of BP and MEA-BP.

关键词

锂离子电池;荷电状态;BP神经网络;子种群自适应趋同策略

Key words

lithium-ion battery;state-of-charge(SOC);back propagation(BP) neural network;subpopulation adaptive convergence strategy

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