Lithium-ion Battery Model Parameter Identification Using Modified Adaptive Forgetting Factor-Based Recursive Least Square Algorithm

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Abstract:
A proficient battery management system (BMS) is constantly expected to make an electric vehicle (EV) more dependable. The battery states like state of charge (SOC) and state of health (SOH) estimation are one of the significant functions of BMS. However, the accuracy of the model-based state estimation strategy is profoundly affected by the exhibition of the battery modeling approach. Particularly, in a continuous application, it is constantly needed to utilize a precise online battery model parameters identification algorithm. In this study, a modified adaptive forgetting factor-based recursive least square (MAFF-RLS) algorithm is proposed. Under which, the forgetting factor values are adaptively updated based on the model voltage error. To implement the proposed algorithm, the first-order RC battery model is utilized. The dynamic load profiles suitable for the EV environment are used for the validation of the proposed algorithm. Besides, to demonstrate the predominance of the MAFF-RLS algorithm over the RLS, and FFRLS algorithms, the estimated voltage

errors such as Max AE, MAE ad RMSE are analyzed. The results demonstrated that the value of the estimated voltage RMSEs using the MAFF-RLS algorithm is lesser than of the voltage RMSEs using RLS and FFRLS algorithms.

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Contents

I. Introduction

With the rise in the demand of the EV in the market, the need for a suitable energy storage system (ESS) is drastically increasing. Several types of ESSs are available in the market however, only a few of them can fulfill the requirement of EV [1]. The Lithium-ion battery (LIB) is the best suitable candidate of ESS for EV application [2]. The LIBs have a high energy/power density, long cycle life, no memory effect, and high C-rate. Though, to operate the battery in a safe operating region, the electronic chip called a battery management system (BMS) is always needed. The basic functions of the BMS are cell balancing, thermal management, control charge/discharge rate, and state estimation. 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 accurate battery SOC estimation, the LIBs can be protected from malfunctioning by controlling the charge/discharge rate, overcharging, and deep discharging [6]. The battery SOC can be defined as the ratio of battery residual active material to the total original active material. The SOC estimation method can be broadly classified into two categories, for example, model-based [7] and data-driven method [6]. Over the most recent few years, different filters, and observers have been used for the model-based SOC estimation [3]. The accuracy of the model-based SOC estimation method depends on the battery modeling method.

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