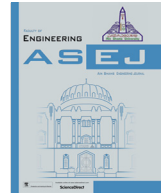




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Battery management solutions for li-ion batteries based on artificial intelligence

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ABSTRACT

The automobile industry is currently undergoing a paradigm change from conventional, diesel, and gasoline-powered vehicles to hybrid and electric vehicles of the second generation. Lithium-ion (Li-ion) batteries have sparked the automotive industry's interest for quite some time. One of the most crucial components of an electric car is the battery management system (BMS). Since the battery pack is an electric vehicle's most significant and expensive component, it must be carefully monitored and controlled. The precise measurement and calculation of the many states of a Li-ion battery's cells, such as the State of Health (SOH) and State of Charge (SOC) is a difficult procedure as they cannot be monitored directly. This paper examines various methodologies and approaches for estimating the SOC and SOH of Li-ion batteries using Artificial Intelligent methods. Six machine learning algorithms are intensively utilized to investigate the Li-ion battery state estimation. The employed methods are linear, random forest, gradient boost, light gradient boosting (light-GBM), extreme gradient boosting (XGB), and support vector machine (SVM) regressors. In comparison to all other models employed in this study, the discharge prediction made using random forest exhibits significantly greater performance at a low loss of accuracy. For instance, with the highest R²-score of 0.999, the random forest regressor achieves only 0.0035, 0.0013, and 0.0097 for mean and median absolute error, and root means squared error (RMSE), respectively. We showed that the state estimation of Li-ion batteries can be precisely predicted using AI methods, which can be combined with a battery management system to improve electric vehicle performance.

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1. Introduction

Because of overexploitation in several sectors, particularly transportation and energy, worldwide stocks of fossil fuels are rapidly depleting. Overexploitation of fossil fuels produces massive volumes of CO₂ and other Green House Gas Emissions (GHGE), which has had a significant impact on the environment and contributed to climate change. The GHGE can be decreased by up to 40% [1] with the use of renewable energy and the electrification

of the transportation sector. Due to the irregular nature of renewable energy sources such as wave, wind, tidal, and solar, an energy storage system (ESS) is used to make the supply to the customer more reliable [2–8]. (SEE Table 1.).

The Electric Vehicle (EV) as shown in Fig. 1 is thought to be the answer to reducing the hazardous pollution emissions from automobiles. Additionally, because electric vehicles can be utilized as energy storage systems to store energy from renewable energy sources, they can engage actively with the electrical grid [9]. This is known as vehicle-to-grid (V2G) interaction. In recent years, many chemistries of energy storage systems (ESSs) have been approved for use in transportation [10]. Li-ion batteries, nickel-cadmium batteries, and lead acid batteries are the most commonly used batteries in EVs. However, Li-ion batteries have grown in

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