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Hybrid method based energy management of electric vehicles using battery-super capacitor energy storage

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ABSTRACT

This paper presents a hybrid technique for managing the Energy Management of a hybrid Energy Storage System (HESS), like Battery, Supercapacitor (SC), and integrated charging in Electric Vehicle (EV). The proposed hybrid method combines the Namib Beetle Optimization (NBO) and Quantum Neural Networks (QNN) technique and is commonly known as the NBO-QNN approach. The proposed energy management technique reduces EV power use and maximizes battery life. QNN forecasts and combines power supply and charge levels to fulfill load needs. EV energy management uses NBO to regulate the output voltage, generate references, and regulate current continuously. Higher energy density battery and power density SC meet vehicle needs. An uncontrolled rectifier with a DC-to-DC buck converter balances charging and ensures energy transmission. The Proposed technique is implemented using the MATLAB platform, and its performance is compared to existing methods. HESS performance is evaluated by comparing it to existing systems. The research shows that the proposed strategy reduces the primary and secondary source stress, enhances performance of charging unit, and extends the life of battery. Furthermore, the NBO-QNN technique outperforms other existing methods, such as the Cooperation Search Algorithm (CSA), Latent Semantic Analysis (LSA), and Grasshopper Optimization Algorithm (GOA). The proposed method displays the best output in all existing Cooperation Search Algorithm (CSA), Latent Semantic Analysis (LSA), and Grasshopper Optimization Algorithm (GOA) methods. The result concludes that the NBO-QNN approach based on THD value is less than existing methods.

1. Introduction

Recently, there has been a notable shift within the automatic industry towards EVs as a sustainable and eco-friendly mode of transportation [1]. This transition is primarily motivated by climate change, air pollution, and fossil fuel depletion concerns [2]. Governments, businesses, and individuals worldwide acknowledge the significance of transitioning from internal combustion engine vehicles to EVs [3]. The current status of electric vehicles indicates rapid growth and increasing market penetration [4]. Global sales of electric vehicles have been consistently rising, with major automakers making substantial investments in EV technology and expanding their electric vehicle product lines [5].

Additionally, advancements in battery technology have significantly enhanced EVs' performance and driving range, alleviating one of the primary concerns for potential buyers. The importance of electric vehicles extends beyond personal transportation [6]. The transportation sector contributes significantly to greenhouse gas emissions, and the widespread use of EVs can be crucial to lowering carbon dioxide emissions and combating climate change. Moreover, electric vehicles offer the potential for decentralized energy storage and grid integration, facilitating the incorporation of renewable energy sources and enabling a more sustainable energy ecosystem [7]. To lower battery aging costs and increase fuel economy, researchers have recently concentrated on understanding the application of improved HESS in plug-in hybrid EVs (PHEVs). They have developed a new PHEV power system configuration

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