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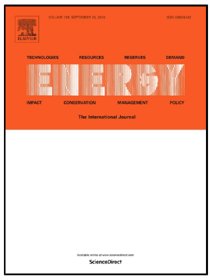

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An Artificial Neural Network-Enhanced Energy Management Strategy for Plug-In Hybrid Electric Vehicles

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Abstract:

In order to achieve near-optimal fuel economy for plug-in hybrid electric vehicles (PHEVs) using the equivalent consumption minimum strategy (ECMS), it is necessary to dynamically tune the equivalent factor (EF). Unlike widely used model-based approaches, this paper proposes a data-driven ECMS that determines the EF using an artificial neural network (ANN). First, by comparing Pontryagin's Minimum Principle (PMP) with the ECMS, the EF is related to the co-state value of the PMP method. Then, an ANN is constructed with three accessible input variables, including the current demanded power, the ratio of the distance travelled to the total distance, and the battery State of Charge (SOC). The neural network is consequently trained using real-world speed profiles. Simulations are performed considering different initial SOC values. The results reveal that the proposed data-driven ECMS demonstrates satisfactory fuel economy compared to global optimization methods like dynamic programming and PMP methods. The computational time of the proposed method relative to the duration of the entire trip indicates a great potential for the development of a time-conscious energy management strategy. Meanwhile, the impact of training sample size on ANN performance is discussed.

Keywords:
Plug-in hybrid electric vehicle;
Equivalent consumption minimum strategy;
Equivalent factor;
Artificial neural network;
Pontryagin's Minimum Principle.