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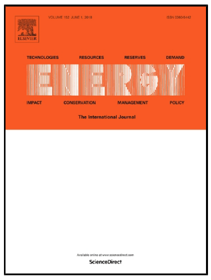


Optimal Energy Management Strategy for a Plug-in Hybrid Electric Commercial Vehicle Based on Velocity Prediction

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# Optimal Energy Management Strategy for a Plug-in Hybrid Electric Commercial Vehicle Based on Velocity Prediction

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**Abstract**

A major advantage of plug-in hybrid electric vehicles is their high fuel economy, which is closely related to their energy management strategy and driving cycles. In this study, an improved velocity prediction method is formulated based on the Markov model and a back propagation neural network. The root mean square error of the predicted velocity for the New European Driving Cycle is 0.1511 m/s when the prediction time is 3 seconds. Moreover, a vehicle test for the velocity prediction algorithm is implemented on a hybrid electric bus, which verifies the reliability and real-time performance. On this basis, a model predictive control-based energy management strategy incorporating the velocity prediction is proposed. In order to lessen the computation and memory burden and constrain the battery's state of charge, a state of charge-based adaptive equivalent consumption minimization strategy is applied to the predictive control-based energy management strategy. By simulation, the proposed velocity prediction-based energy management strategy improves fuel economy by 3.11% and 7.93% for a plug-in hybrid electric commercial vehicle in the New European Driving Cycle, while 2.96% and 11.02% in the Worldwide Harmonized Light Vehicles Test Procedures, when compared with the adaptive equivalent consumption minimization strategy and equivalent consumption minimization strategy, respectively.

**Keywords**: PHECV; velocity prediction; Markov model; BP neural network; EMS; MPC

**Highlights**

- A velocity prediction algorithm using a Markov model and BP neural network is made.
- A velocity prediction-based EMS combining the AECMS with MPC is formulated.
- An MPC-based EMS using less computation and memory burden is proposed.
- The fuel economy is improved by using the velocity prediction-based EMS.

## 1 Introduction

A plug-in hybrid electric vehicle (PHEV) has a larger battery capacity and longer driving range in comparison to a traditional hybrid electric vehicle (HEV) [1]. Energy management strategies (EMSs) are critical for the improvement of PHEV fuel economy [2], which is closely related to the vehicle's driving cycles [3]. Predictive EMSs, which are capable of obtaining better fuel economy, can be implemented in real-time with a short period of future driving cycle prediction [4, 5]. The driving cycle prediction-based EMSs are mainly based on velocity prediction, and the fuel economy optimization potential is closely related to the system's prediction accuracy and real-time performance.