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Poster

Innovations in FCHEV Power Management: A Fusion of Machine Learning and Physics-Based Models†

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Abstract

In the green motor vehicles era, fuel cell hydrogen electric vehicles (FCHEVs) are becoming promising alternatives. Thus, ensuring proper operation of FCHEVs, solely depends on advanced energy management systems (EMS). In this light, this work deeply looks into how combining machine learning and physics-based models can make FCHEVs operate effectively through improved EMS. The study extensively analyzes how machine learning and physics-based models operate together in FCHEV-EMS. It therefore breaks through existing research and identifies insights, challenges, and potential future directions. It also looks closely at how machine learning meets challenges in adapting to real-time and handling changing conditions. To gain better understanding of these issues, the study further recommends innovative ways to integrate machine learning flexibility within precision of physics-based modeling. It therefore reveals intriguing potential for additional study in the world of FCHEV-EMS. It represents, the integration of machine learning and physics-based models as a potent technique to deal with EMS difficulties and accelerate advances in FCHEV energy management. In the end, it outlines significant findings, addressing why this integrated strategy is crucial in making FCHEVs leading worldwide sustainable transportation. Through its comprehensive review and strategic perspectives, this initiative aims to catalyze innovations that actively contribute to the sustainable advancement of FCHEVs.

Keywords:

FCHEV; Power Management; Machine Learning; Physics-Based Models; Sustainable Transportation; Research Opportunities.

1. Introduction

In the pursuit for sustainable transportation, fuel cell hybrid electric vehicles (FCHEVs) have emerged as a promising alternative to traditional combustion engine vehicles. The efficient operation of FCHEVs hinges on advanced energy management systems (EMS), which ensure optimal performance and energy utilization [1–3]. This study delves into the integration of machine learning and physics-based models to enhance the effectiveness of FCHEV-EMS [4–7]. By combining the adaptability of machine learning with the precision of physics-based modeling, researchers aim to address the dynamic challenges faced by FCHEVs and propose innovative solutions for real-time energy management (see Figure 1). This comprehensive analysis sheds light on the synergy between these two approaches and identifies key insights, challenges, and future directions for research in this field.

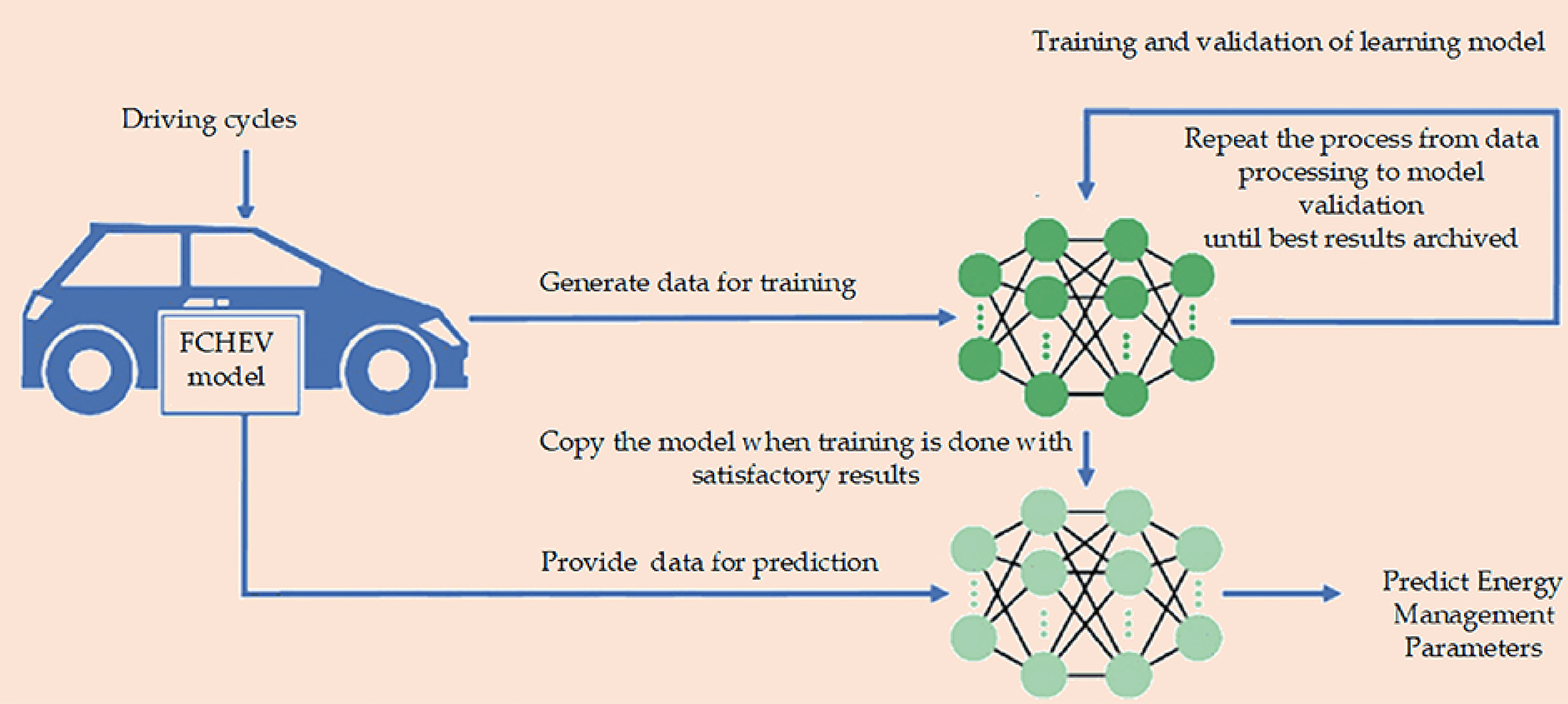

Figure 1. Flow diagram illustrating the integration of physics-based models and machine learning for enhanced energy management in FCHEVs.

2. Important Findings

1. Synergy between Machine Learning and Physics-Based Models: Machine learning algorithms can complement physics-based models by providing adaptive and real-time responses to varying operational conditions in FCHEVs. This integration enhances the accuracy and reliability of EMS, leading to more efficient energy management [7].

2. Challenges in Real-Time Adaptation: One of the significant challenges identified is the ability of machine learning models to adapt to real-time changes and unpredictable conditions. The research underscores the importance of developing robust algorithms that can handle these variations without compromising performance [8].

3. Innovative Integration Strategies: The study recommends several innovative methods for integrating machine learning with physics-based models. These strategies aim to leverage the flexibility of machine learning while maintaining the precision and reliability of physics-based approaches. This hybrid model is crucial for advancing FCHEV technology [1–7].

4. Potential for Further Research: The findings suggest intriguing opportunities for future research in FCHEV-EMS by exploring deeper into the integration of these models, and uncover new ways to improve the efficiency and sustainability of FCHEVs.

5. Strategic Perspectives on Sustainable Transportation: The research outlines that the integrated approach is vital for making FCHEVs a leading solution in global sustainable transportation. It emphasizes the role of advanced EMS in reducing emissions and promoting the adoption of green motor vehicles.

By providing a comprehensive review and strategic insights, this study aims to catalyze innovations in FCHEV-EMS, contributing significantly to the sustainable advancement of transportation technologies.

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