PHD THESIS PROJECT

Energy management of fuel cell hybrid electric vehicles using advanced machine learning technique

Abstract — During the last few decades, electric vehicles (EVs), and most recently hybrid electric vehicles powered by fuel cells (FCHEVs) are widely considered as a clean transport solution. Proton exchange membrane fuel cell (PEMFC) associated with a hydrogen tank is considered as a more suitable candidate for long-range EVs, due to fuel cell's high-power density, and easy to refuel (only a couple of minutes to fill a full tank of hydrogen). However, a stand-alone fuel cell system cannot be sufficient to satisfy the power demand from the vehicle and cannot recover energy from vehicle deceleration. Thus, a FCHEV has always a hybrid powertrain configuration. To achieve optimal energy distribution, a lithium-ion battery is generally used as energy storage devices in FCHEVs. The lithium-ion battery is also used to provide the required power to the load during the heating up of the fuel cell and recover the kinetic energy during the braking phase.

To find the maximum energy efficiency situation and the highest performance of fuel cell hybrid energy powertrain, many optimal control strategies were proposed in literature. A common drawback of methods proposed is that the patterns of real driving cycles are not considered. The real driving cycle may contain different cycle patterns in a period, which cannot be simply classified as a single driving cycle. For different types of driving cycles (highway, suburban, city, etc.), the demanded powers are also different. For example, a higher average power is required when the EV is driving under the highway cycles; more peak power supply is required when the EV is driving under the city cycles. Thus, these different characters of power demands have different requirements for the control. Therefore, including driving pattern factors in energy management strategy will lead to a better fuel consumption and Energy Storage System usage in term of both performance and durability. Nevertheless, the real driving cycles are hard to predict, and due to the various behavior of drivers, an accurate model of driving cycle is also very difficult to be obtained. Thanks to the recent development of marching learning techniques, using advanced machine learning for the modeling of real driving cycles, as well as to develop the associated energy management control of FCHEVs, could be a viable solution.

This PhD project is therefore expected to deal with this issue by applying state-of-art machine learning techniques for the energy management of fuel cell hybrid electric vehicles, where the main steps should be vehicle and driving cycle modeling and simulation, machine learning based control development, and experimental validation.

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