Mechanical Engineering Master's Defense

Power Management Strategy of a Fuel Cell Hybrid Electric Vehicle with Peak Power Shaving Using Ultra-Capacitor

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abstract

Fuel cell vehicles are the most interesting development in the automotive industry. It is seen as an alternative to Internal Combustion Engine (ICE). The fuel cell vehicles are always hybridized with some Energy Storage System (ESS) due to the slow dynamics of the fuel cell. Usually battery packs are used widely in all the vehicles that use a motor to propel the vehicle. But lately due to the development of the Ultra-Capacitor are seen as something that can be used as part of ESS. But it has its own limitations. This thesis investigates how both batteries and Ultra-Capacitor can be used to improve the dynamics and fuel economy.

This thesis uses a Rule based power management strategy that considers the strength and weaknesses of each power source and uses them at appropriate instances. Batteries have high energy density but low power density. So they are good for drawing power when cruising on a highway since it needs more energy but less power. Ultra-Capacitor on the other hand have high power density but low energy density. So they are great for start/stop and acceleration like situations. Fuel cell operate with high efficiency in the mid region of its power range. With a power management strategy with all these criteria, reduces the consumption of hydrogen and improves fuel efficiency. Improvement in the operations of the battery are seen. An improvement of 56% in the hydrogen is seen for US06 drive cycle. Further a driving pattern recognition method was also used to switch control strategies between aggressive and city driving. This model can further be improved using mathematical optimization techniques like Response Surface Method.

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