Abstract

Paper Title: MPC-Based Real-Time Control Strategy of Power-Split Hybrid Electric Vehicle

Key Words: Power-Split Hybrid Electric Vehicle; Real-Time; MPC

Topics: Advanced Hybrid Electric Vehicle; Future Automotive Powertrain

Research and/or Engineering Questions/Objective:
The power-split Hybrid Electric Vehicle (HEV) has great potential in energy efficiency improvement and emission reduction. To fully exploit the potential, energy management control needs to be designed to determine the optimal power split ratio between the engine and the electric motor. The control objective is to satisfy the power demand and to optimize fuel economy adjust to all driving conditions.

Methodology:
In this paper a real-time methodology was investigated to improve the fuel economy of power-split HEV. The Systematic Efficiency was formulated as an optimal control function. To integrate the preview information for power-split HEV, the Model Predictive Control (MPC) strategy was utilized to obtain the power split between the combustion engine and electrical machines and the system operating points at each sample time. In the MPC strategy, the future information about the power demand was forecast. Then, the on-line rolling optimization was used to get the optimal power splitting. At last, the actual results were adopted to calibrate the predicted value of power demand.

Results
In this paper simulation on a closed-loop model of a power-split HEV over a standard drive cycle is present. Compared with a rule-based control strategy without any preview, the MPC-based real-time optimal control strategy makes the power parts (engine and motors) working in a more rational range, the control having a smaller fluctuation and the power response more accurate.

Limitations of this study
The prediction of future information cannot be quick and accurate. The real-time optimal control has a large amount of numerical calculation.

Innovations:
Most of the existing techniques rely on knowing the future power demand to set up deterministic dynamic programming problems or rule-based algorithms. Even though these techniques have been already tested in real vehicles with good results, they suffer a few drawbacks. Both of them strongly depend on the specific driving cycle used for their tuning, and might be neither optimal nor charge-sustaining under other cycles. But the real-time control strategy can adjust to all driving conditions.

Conclusions
Compared with the rule-based control strategy without any previews, the MPC-based real-time optimal control strategy improves the optimized efficiency made the operating point of each power parts more rational, that also reduces the overshoot and fluctuation in the control process. The real-time optimal control strategy based on MPC shows a noticeable improvement in fuel economy and control performance.