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Engine Start-Up Robust Control for a Power-Split Hybrid System Based on μ Synthesis Method

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Abstract

Engine starting control is of great importance for the mode transition process from pure electric mode to electronic-Continuously Variable Transmission (e-CVT) mode for an input power-split system. To suppress the impact of engine start-up on the powertrain, and improve the vehicle ride comfort during the mode transition process, this study proposes an engine start-up robust control strategy based on the μ synthesis method. Firstly, the models of powertrain dynamics and the engine ripple torque (ERT) are established, and the mode transition process is analyzed. Secondly, the engine start-up robust control strategy is proposed to distribute the torque of each power source. The optimal engine cranking speed trajectory is designed based on a dynamic programming algorithm aimed at reducing the engine start-up time and improving the vehicle ride comfort. Finally, to track the optimal engine speed trajectory and the desired power output-end speed, a robust controller is developed based on the μ synthesis method, which considers the system's parametric perturbations and external disturbances. Simulation results on the MATLAB/Simulink platform indicate that the proposed approach can effectively reduce the vehicle longitudinal jerk during the engine starting process and possess superior robust performance against parametric perturbations and external disturbances.

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TABLE 3 Summary of the results.

Case	Longitudinal jerk (m/s^3)	Control deviation (%)
A	13.99	—
B	13.97	0.1
C	14.23	1.7
D	14.66	4.7

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