

Dynamic Analysis and Clutch Adaptive Prefill in Dual Clutch Transmission

Authors : Bin Zhou, Tongli Lu, Jianwu Zhang, Hongtao Hao

Abstract : Dual clutch transmissions (DCT) offer a high comfort performance in terms of the gearshift. Hydraulic multi-disk clutches are the key components of DCT, its engagement determines the shifting comfort. The prefill of the clutches requests an initial engagement which the clutches just contact against each other but not transmit substantial torque from the engine, this initial clutch engagement point is called the touch point. Open-loop control is typically implemented for the clutch prefill, a lot of uncertainties, such as oil temperature and clutch wear, significantly affects the prefill, probably resulting in an inappropriate touch point. Underfill causes the engine flaring in gearshift while overfill arises clutch tying up, both deteriorating the shifting comfort of DCT. Therefore, it is important to enable an adaptive capacity for the clutch prefills regarding the uncertainties. In this paper, a dynamic model of the hydraulic actuator system is presented, including the variable force solenoid and clutch piston, and validated by a test. Subsequently, the open-loop clutch prefill is simulated based on the proposed model. Two control parameters of the prefill, fast fill time and stable fill pressure is analyzed with regard to the impact on the prefill. The former has great effects on the pressure transients, the latter directly influences the touch point. Finally, an adaptive method is proposed for the clutch prefill during gear shifting, in which clutch fill control parameters are adjusted adaptively and continually. The adaptive strategy is changing the stable fill pressure according to the current clutch slip during a gearshift, improving the next prefill process. The stable fill pressure is increased by means of the clutch slip while underfill and decreased with a constant value for overfill. The entire strategy is designed in the Simulink/Stateflow, and implemented in the transmission control unit with optimization. Road vehicle test results have shown the strategy realized its adaptive capability and proven it improves the shifting comfort.

Keywords : clutch prefill, clutch slip, dual clutch transmission, touch point, variable force solenoid

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