

Modeling and Testing of the Hydro-Mechanical Synchronization System for a Double Clutch Transmission

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Synchronization is a core component in the automotive powertrain. It uses friction and locking elements to synchronize the occurring speed difference during gear shifting. The optimization of this shifting process is of high interest in respect to fuel consumption and comfort considerations. Moreover, for the model-based calibration of automated transmissions, detailed simulation models of the synchronization system are also necessary. Highly accurate models allow simulation of nonlinear effects having a major influence on the shifting process, it can supply more realistic reflects during synchronization and give a more exact guidance for the calibration. Currently, with less detailed models only rough estimations of the shifting process are possible, but it has a reduced meaning for the precise calibration.

This paper uses a 7-speed double clutch transmission (DCT) as the research object and presents the detailed hydro-mechanical synchronization model with 5 stages (pre-sync, locking, unlocking, turning hub and engagement) instead of 3 stages (neutral position, friction phase and engaged position). Firstly, an introduction about the theory of the synchronization system is given. This supplies a detailed understanding of its working principle. Subsequently, a Modelica[®] based synchronization model consisting of hydraulic system, hydro-mechanic actuators and gear shifting synchronizers is presented and discussed in detail. Finally, these modules are respectively evaluated based on different test cases (such as mechanical module testing in Figure 1). A comparison with test bench measurement data from an automated manual transmission (AMT) system is also included in the end (see Figure 2).

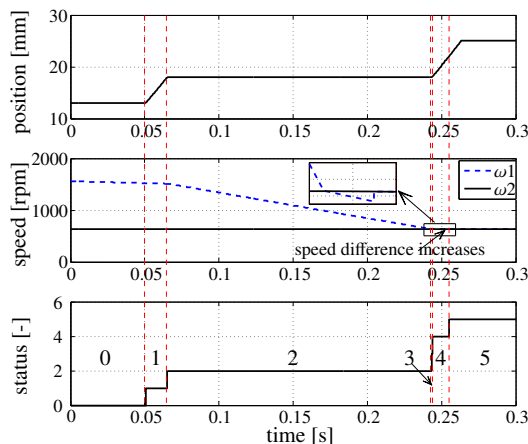


Fig. 1: Simulation results of mechanical module

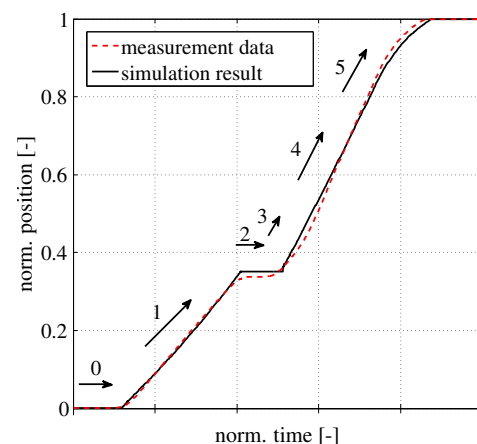


Fig. 2: Synchronization: Comparison of simulation results with measurements