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Driveline Modeling and Control

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ABSTRACT

A vehicular driveline is the system used to transfer engine torque to the wheels. Resonances in the elastic parts of the driveline are important to handle when control of the engine and the transmission is optimized.

Gear shifting by engine control is a new approach for automatic gear shifting with disengaging the clutch replaced by engine control. Resonances are excited in an uncontrolled driveline if the time for shifting to neutral gear is decreased. This leads to problems with disengaging the old gear and synchronizing speeds for engaging the new gear. Internal driveline torque control is a novel idea for handling resonances and increasing shift quality. By estimating the transmitted torque and controlling it to zero by engine control, the gear can systematically be disengaged with minimized driver disturbances and faster speed synchronization. Field trials show fast shifts to neutral gear, despite disturbances and driveline oscillations at the start of the gear shift. The control scheme is simple and robust against variations among different gears. Furthermore, damping of driveline resonances can be obtained with an observer in combination with a PID feedback structure, despite the higher order driveline system.

Traditional diesel engine speed control maintains a well damped engine speed set by the driver. However, the resonance modes of the driveline are easily excited by accelerator-position changes or by road disturbances. A speed-control strategy is proposed that includes the behavior of the driveline, and reduces driveline resonances and vehicle shuffle by engine control. Implementation shows significant reduction, also when facing nonlinear torque limitations from maximum torque and diesel smoke delimiters.

A basis for both applications is a driveline model with a drive-shaft flexibility, and an analysis of the control problem. The model captures the first main resonance mode of the driveline and is sufficiently detailed for control design. Furthermore, the response time of the diesel engine is shown to be sufficient for reducing the first resonance mode.

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