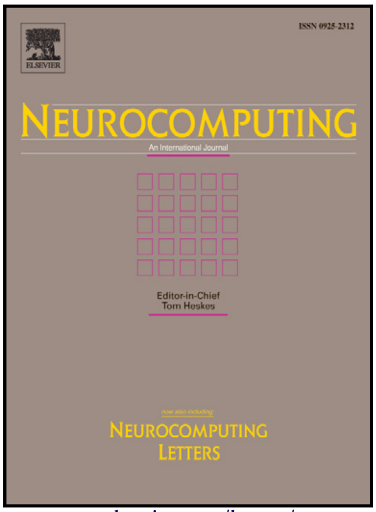

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Abstract

In this paper, a robust shift control strategy of a heavy duty vehicle powertrain system is investigated for enhancing shift quality. To analyse the shift transient phenomena, the dynamic models for various powertrain components, such as engine, torque converter, transmission and drivetrain are developed. Three different robust adaptive control laws are derived for the different process control that reduces the output torque during the gear shifts. In deriving the control laws, both the engine and automatic transmission dynamics have been included. In order to overcome the challenge of the relevant variables characterizing the performance of the power train are not measurable because of sensor cost and reliability considerations. The integrated controller proposed uses only angular velocity signals, such as engine speed, turbine speed and output speed which are inexpensive to measure and easy to implement. Finally, the designed control strategy is tested on a heavy-duty vehicle equipped with automatic transmission. Results from the experimental studies show that the proposed control strategy can effectively reduce shift shock and smooth the gear shift.

Index Terms

Shift control, Adaptive control, Shift shock, Pressure control, heavy-duty vehicle

I. Introduction

The automatic transmissions utilize clutches to transfer torque at various speed ratios through the transmission [1]–[4]. When shifting between gear ratios, the transmission control unit (TCU) should synchronize the engagement of the on-coming clutch and the disengagement of the off-going clutch, this process is called clutch-to-clutch shift control [3], [5]–[9]. Clutch-to-clutch shift control system for automatic transmission is designed to provide smooth transients for passenger comfort and better component durability [10]. Advantages of automatic transmissions are relying primarily on clutch-to-clutch shifts, over transmissions relying primarily on overrunning clutches, include simplicity of mechanical design and savings in transmission weight and size, which are beneficial in terms of fuel economy and production costs [8], [11]. As the number of speeds in automatic transmissions increases in order to enable gains in fuel economy while meeting drivability and performance goals, these savings become more significant. However, control of clutch-to-clutch shifts to achieve shift quality comparable to those involving overrunning clutches is a challenging problem. In a clutch-to-clutch shift, smoothness of the shift requires timing coordination between control actions involving the on-coming as well as the off-going clutches. Improper coordination results

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