Mechanical Systems and Signal Processing 25 (2011) 1911–1922

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

journal homepage: www.elsevier.com/locate/jnlabr/ymssp

Simulation and control of an electro-hydraulic actuated clutch

Andreea-Elena Balau *, Constantin-Florin Caruntu, Corneliu Lazar

Department of Automatic Control and Applied Informatics, "Gheorghe Asachi" Technical University of Iasi, Str. Prof. dr. docent Dimitrie Mangeron, Number 27, Iasi 700050, Romania

ARTICLE INFO

Article history:
Received 4 February 2010
Received in revised form
1 December 2010
Accepted 13 January 2011
Available online 20 January 2011

Keywords:
Simulation
Dynamic modelling
Hydraulic actuator
Wet clutch control
Networked predictive control strategy
Time-varying delay

ABSTRACT

The basic function of any type of automotive transmission is to transfer the engine torque to the vehicle with the desired ratio smoothly and efficiently and the most common control devices inside the transmission are clutches and hydraulic pistons. The automatic control of the clutch engagement plays a crucial role in Automatic Manual Transmission (AMT) vehicles, being seen as an increasingly important enabling technology for the automotive industry. It has a major role in automatic gear shifting and traction control for improved safety, drivability and comfort and, at the same time, for fuel economy. In this paper, a model for a wet clutch actuated by an electro-hydraulic valve used by Volkswagen for automatic transmissions is presented. Starting from the developed model, a simulator was implemented in Matlab/Simulink and the model was validated against data obtained from a test-bench provided by Continental Automotive Romania, which includes the Volkswagen wet clutch actuated by the electro-hydraulic valve. Then, a predictive control strategy is applied to the model of the electro-hydraulic actuated clutch with the aims of controlling the clutch piston displacement and decreasing the influence of the network-induced delays on the control performances. The simulation results obtained with the proposed method are compared with the ones obtained with different networked controllers and it is shown that the strategy proposed in this paper can indeed improve the performances of the control system.

1. Introduction

Nowadays, clutch pedals as well as automatic transmissions, double-clutch transmissions, hybrid drive concepts and chassis control systems increasingly require open-loop and closed-loop controlled actuators. The introduction of a new actuator opens up new opportunities for controlling the engine and drive-line, and new strategies that can improve the drive-line performance are predictable. In the last decades, the use of control systems for automated clutch and transmission actuation has been constantly increasing; a clear trend is that automatic clutch systems will be introduced and used in a wider variety of applications, which would benefit from advanced clutch control. For example, start and stop strategies can be employed and in addition the clutch control can be utilised in automated manual transmissions to reduce the time for gear changes. Furthermore, clutch control is also a factor in look-ahead control.

Recent attention has focused on modelling different valve types used as actuators in automotive control systems: physics-based nonlinear model for an exhausting valve [1], nonlinear state-space model description of the actuator that is derived based on physical principles and parameter identification [2,3], nonlinear physical model for programmable

* Corresponding author.
E-mail addresses: abalau@ac.tuiasi.ro, andreea1984@yahoo.com (A.-E. Balau), caruntuc@ac.tuiasi.ro (C.-F. Caruntu), clazar@ac.tuiasi.ro (C. Lazar).

0888-3270/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ymssp.2011.01.009