University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

JIAN DONG

BA (Tongji University, 2009)

"Modeling and Real-Time Optimal Energy Management for Hybrid and Plug-in Hybrid Electric Vehicle"

Department of Mechanical Engineering

Thursday, January 12, 2017
9:00 A.M.
Engineering Office Wing
Room 430

Supervisory Committee:
Dr. Zuomin Dong, Department of Mechanical Engineering, University of Victoria (Co-Supervisor)
Dr. Curran Crawford, Department of Mechanical Engineering, UVic (Co-Supervisor)
Dr. Wu-Sheng Lu, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Jie Chen, Department of Mechanical Engineering, Indiana University

Chair of Oral Examination:
Dr. Kara Shaw, School of Environmental Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Today hybrid electric propulsion technology provides a promising and practical solution for improving vehicle performance, increasing energy efficiency, and reducing harmful emissions, due to the additional flexibility that the technology has provided in the optimal power control and energy management, which are the keys to its success.

In this work, a systematic approach for real-time optimal energy management of hybrid electric vehicle (HEV) and plug-in hybrid electric vehicle (PHEV) has been introduced and validated through two HEV/PHEV case studies. Firstly, a new analytical model of the optimal control problem for Toyota Prius HEV with both offline and real-time solutions was presented and verified through Hardware-in-Loop (HIL) real-time simulation. Secondly, the new online or real-time optimal control algorithm was then extended to a multi-regime PHEV by modifying the optimal control objective function and introducing a real-time implementable control algorithm with an adaptive coefficient tuning strategy. A number of practical issues in vehicle control, including drivability, controller integration, etc. are also investigated. The new algorithm was also validated on various driving cycles using both Model-in-Loop (MIL) and HIL environment.

This research better utilizes the energy efficiency and emissions reduction potentials of hybrid electric powertrain systems, and forms the foundation for the developments of next generation HEVs and PHEVs.