Workshop: Model-Based and Model-Guided Approaches for Automotive Powertrain Calibration and Control

Organizers and Speakers:
Prof. Guoming Zhu (Michigan State University, USA)
Prof. Xiang Chen (University of Windsor, Canada)

Time: 14:00—17:30, Sunday, July 9, 2017

Abstract: Design and manufacturing of automotive engines have been facing the heavy challenge for improved fuel economy with reduced emissions due to climate change, which requires very precise control of the entire engine operation process in order to squeeze the potentials. This half-day workshop introduces the need and the-state-of-the-art research for applying model-based and model-guided data-driven optimization techniques to calibration and control of automotive powertrain systems. In particular, we first discuss the control-oriented modeling approach for automotive powertrain and how these models could be initiated and validated by real-time hardware-in-loop simulations. The model-based and model-guided calibration and control development for automotive powertrain systems will then be discussed and compared with the traditional approaches. Especially, model-based feedforward control will be discussed due to its ability of improving transient engine performance that is critical for both fuel economy improvement and emission reduction. The application examples of the model-based and model-guided control of engine mechatronic actuation subsystem and internal combustion engine systems will be discussed in details. This workshop will also present both off-line and on-line data driven approaches for automotive powertrain control.

Who should attend: This workshop is designed to facilitate both automotive control researchers from academic communities and engineers from automotive industry to conduct model-based and model-guided innovation design for automotive powertrain systems that is the trend of future internal combustion engines based powertrain systems. It is intended to share with audiences the motivation, rationale, challenges, and achievements in the model-based and model-guided powertrain (internal combustion) control approach. Those who are interested in the model-based and model-data integrated approaches for control and optimization would also find the workshop beneficial in terms of both new concepts and applications.

The workshop will be organized as follows:

a) Introduction
 1. Status review of model-based automotive engine control
 2. Traditional engine and powertrain control development process
 3. Model-based engine and powertrain control and its development process
 4. Two key elements for model-based control: control-oriented model and model-based control strategy
b) Control-oriented modeling and model-based control for engine systems
 1. Requirement of the control-oriented engine models

2. Control-oriented engine modeling (past, now, and future)
3. Model-based engine control (feedforward and feedback)

c) Model-guided data-driven optimization approach for engine control and calibration
1. Introduction to data-driven optimization
2. On line observer design for engine operation
3. Model-guided extremum seeking control and calibration of engine operations
4. Data-driven prediction based optimization for electronic throttle body actuation
5. Open issues in model-guided data driven optimization for automotive systems.

About Speakers

Guoming (George) Zhu received the Ph.D. degree in aerospace engineering from Purdue University, West Lafayette, IN, in 1992. He is currently a full professor in the Department of Mechanical Engineering (ME), and Electrical and Computer Engineering (ECE) at Michigan State University, East Lansing, MI. Prior to joining the MSU, he was a Technical Fellow in advanced powertrain systems at Visteon Corporation. He also worked for Cummins Engine Co., Ltd as a Technical Advisor. His teaching interests focus on control classes at both undergraduate and graduate levels; and his current research interests include closed-loop combustion control of internal combustion (IC) engines, engine system modeling and identification, hybrid powertrain control and optimization, linear parameter varying control, etc. He has more than 30 years of experience related to control theory, engine diagnostics, and combustion control. He has authored or coauthored more than 170 refereed technical papers, two books, and received 40 U.S. patents. Dr. Zhu was an Associate Editor for the ASME Journal of Dynamic Systems, Measurement, and Control, and currently, he is an associate editor for ASME Dynamics and control Magazine and a member of editorial board for the International Journal of Powertrain. He is a Fellow of the SAE and ASME.

Xiang Chen received the Ph. D. degree in Systems and Control from Louisiana State University in 1998. Since 2000, he has held cross-appointed faculty position with Department of Electrical and Computer Engineering and Department of Mechanical, Automotive and Materials Engineering at the University of Windsor and is currently a Professor in the Department of Electrical and Computer Engineering. He has made fundamental contribution to $\mathcal{H}_\infty$ Gaussian filtering and control and to the control of nonlinear systems with bifurcation and also made significant contribution to industrial applications of control and optimization in automotive systems through extensive collaboration with automotive industries. Some of the deliverables have been patented by relevant companies or became transferred technologies to relevant companies. He is currently an *Associate Editor* for *SIAM Journal on Control and Optimization* and a *Technical Editor* for *IEEE/ASME Transaction on Mechatronics*. His research interests include model-data integrated optimization, automotive control systems, and control of systems with complexities. He received several research awards including the New Faculty Award from Canadian Foundation of Innovation and from Ontario Centre of Excellence—Materials and Manufacturing Ontario. He has published more than 140 refereed book chapters and technical papers. He is a registered Professional Engineer in Ontario, Canada.