"Robust and Optimal Switching Linear Parameter-Varying Control with Applications"

PAN ZHAO

PhD candidate
Control Engineering Lab
The University of British Columbia

Systems & Controls Seminar:

Tuesday, July 31, 2018
2 pm in ECE 118

Abstract: Linear parameter-varying (LPV) control is a systematic way for gain-scheduling control of a nonlinear or time-varying system that has dynamic variations in its operating range. However, when the dynamic variations are large, LPV control may give conservative performance. One way to reduce the conservatism is switching LPV (SLPV) control, in which we partition the parameter variation set into subsets, design one local LPV controller for each subset, and switch among those local controllers according to some switching rules. In this talk, we present three contributions to the SLPV control theory. First, we propose a novel approach to designing SLPV controllers with guaranteed stability and performance even when the scheduling parameters cannot be exactly measured. Secondly, we show the effect of switching surfaces on the performance of an SLPV controller and give an algorithm based on particle swarm optimization to optimize the switching surfaces. Finally, this talk also includes a novel approach to designing SLPV controllers that could yield significantly improved local performance in some subsets without much sacrifice of the worst-case performance. This is different from the traditional approach that often leads to similar performance in all the subsets.

On the application side, we address three practical problems using the developed theory. The first one is control of miniaturized optical image stabilizers with product variations. Specifically, multiple parameter-dependent robust (MPDR) controllers are designed to adapt to the product variations, while being robust against the uncertainties in the measurement of the scheduling parameters that characterize the dynamics variation. The second one is air-fuel ratio control of an automotive engine, for which SLPV controllers are designed to address the variation of the dynamics with the engine speed and air mass flow. The last one is control of a floating offshore wind turbine. SLPV controllers are designed for regulating the power and the generator speed as well as reducing the platform motion in a large operating range.

Pan Zhao

Pan Zhao is a Ph.D. candidate and a Vanier Scholar in the Department of Mechanical Engineering at the University of British Columbia, Vancouver, BC, Canada. Currently, he is also a visiting researcher in Autonomous Learning Lab at the University of Massachusetts Amherst. He received the B.S. and M.S. degrees from Beihang University, Beijing, China, in 2009 and 2012, respectively. From 2012 to 2013, he was a modeling & simulation engineer in Hirain Technologies, Beijing, China. He did an internship in Siemens Corporate Technology from April 2017 to Oct 2017. His current research interests include robust and gain-scheduling control, model predictive control, robotics and reinforcement learning.

ELECTRICAL & COMPUTER ENGINEERING