LPV observer and control design methods for vehicle dynamics

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Biography

Olivier Sename was born in Lille (France) in 1969. He received a degree in Mechanical Engineering and Automatic Control from the Ecole Centrale Nantes in 1991, where he also completed his Ph.D. degree in Automatic control in 1994 on the topic of time-delay systems. He is now Professor at the Institut Polytechnique de Grenoble (Grenoble INP) within GIPSA-lab. His main research interests include Linear Parameter Varying systems and automotive applications. He has supervised 30 Ph.D. students and is the (co-)author of 2 books, 55 international journal papers, and more than 200 international conference papers.

He has been the General Chair of the IFAC Joint conference 2013 "Symposium System Structure and Control", Workshops on "Time-Delay Systems" and on "Fractional Differentiation and Its Applications" in Grenoble , of the 1st IFAC Workshop on Linear Parameter Varying Systems 2015 in Grenoble and he was the IPC Chair of the 2nd IFAC Workshop LPVS 2018 in Brazil.

He is Associated Editor of the IEEE Control Systems Letters journal, IPC Technical Associate Editor of the IFAC World Congress 2017 & 2014, and member of the Conference Editorial Board of the European Control Conferences 2009, 2013 – 2019.

He has led several industrial (ST Microelectronics, Delphi, SOBEN, Renault, Volvo Trucks, JTEKT) and international (Mexico, Italy, Hungary) collaboration projects.

Abstract

This talk aims at presenting the interest of Linear Parameter Varying (LPV) methods for vehicle dynamics control. While the use of this approach to deal with non-linear systems is now well established, it will be shown, further, to be flexible and robust enough to handle several types of constraints and objectives such as: actuator non linearities, real-time performance adaptation, control allocation and coordination for MIMO systems, fault/unknown input estimation, fault tolerant control w.r.t sensor/actuator failures.

In the first part, we will consider the semi-active suspension observation/control problem, for which the challenge is the ability to take into account the non-linear behavior damper and its loss of efficiency in the presence of faults. An LPV method to estimate the state-of-health of the damper will be presented.

In the second part the synthesis of an LPV / H_∞ MIMO vehicle dynamic controller, involving suspension, steering and braking actuators, is proposed to improve the vertical and lateral performances. A hierarchical structure is developed with a gain-scheduling control of the 3 subsystems according to the

driving situation evaluated by a specific monitor. Simulation results using vehicle models validated on a real car, will show the efficiency and robustness of the proposed solutions.

In the third part, a Linear Parameter-Varying controller is developed for a Column-type Electric Power Steering systems. It includes an LPV H∞ state-feedback plus an H∞/H2 Proportional Integral observer for state and driver torque estimation. The whole observer-based control has been implemented in real-time using dSpace / MicroAutobox on a test car. Some driving tests have been carried out on a test track, and promising results are achieved regarding both estimation and control performances.