UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

PhD course announcement

Title: The Linear Parameter Varying approach: theory and application

Lecturer: Prof. Olivier SENAME, Ph.D.

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***Short bio notes**: Prof. Olivier Sename received a Ph.D. degree from Ecole Centrale Nantes in 1994. He is Professor at the Institut Polytechnique de Grenoble within GIPSA-lab. His main research interests include Linear Parameter Varying systems and automotive applications. He is the (co-)author of 3 books, 90 international journal papers, and more than 260 international conference papers. He was the General Chair of the IFAC Joint Conference SSSC-TDS-FDA 2013, of the 1st IFAC Workshop on Linear Parameter Varying Systems 2015 and he was the IPC Chair of the 2nd and 4th IFAC Workshop LPVS 2018 & 2022. He was Program Chair of the 10th Interna- tional Conference on Mechatronics and Control Engineering in 2021 and 2023. He presented several plenary talks (IFAC SSSC 2019, IFAC LPVS 2021, ICMCE 2021, ICSTCC2015). He is Associated editor of the European Control Conferences and has been AE of the IEEE CSS Letters for 5 years. He is member of the IFAC TC 2.2 Linear Control Systems and 7.1 Automotive Control. He has led several industrial (Renault, Volvo Trucks, JTEKT, Delphi) and international (Mexico, Italy, Hungary, Spain) collaboration projects. He has super- vised 34 Ph.D. students.*

Credits: 4 CFU

Overview

This course is concerned with Linear Parameter Varying (LPV) systems. In the first part we will provide definitions of such systems, as well as some modelling methods to get LPV systems state space representations from physical systems or from non linear models. Then properties such as controllability, observability and stability will be defined and some characterizations will be presented and discussed. The second part deals with control design methods for LPV systems. We will mainly put the focus on the referred to as polytopic and grid-based approaches, for which state feedback and dynamical output feedback control design methods will be given. The synthesis of state observers will also be considered. The third part is dedicated to the application of LPV methods to automotive systems. Two main cases will be presented: the modelling and control of semi-active suspension systems, and the multivariable control of Vehicle Dynamics. The objective will be to see different ways to use the potential of LPV approaches in realistic cases. The last part will be dedicated to the training phase in Matlab/Simulink in order to be able to model, analyze, control and simulate LPV systems for some simple examples.

There will be a final assessment.

Schedule

Lecture	Date	Time	Topics
1	25/05/2023	14.30-17.30	Modelling & Properties of LPV systems
2	29/05/2023	14.00-17.00	LPV Control & Observation
3	30/05/2023	10.00-13.00	LPV methods for Automotive system
4	01/06/2023	10.00-13.00	Matlab exercices
5	X/Y/2023	TBD	Assessment

Content

Lesson 1 – Modelling & Properties of LPV systems (3H). What is a Linear Parameter Varying systems? Modelling: How to approximate a nonlinear system by an LPV one? Identification of LPV systems Controllability, observability. Stability analysis: quadratic stability, Robust stability or Parameter Varying Lyapunov stability, L2 stability.

Lesson 2 – LPV Control & Observation (3H). Presentation of polytopic and grid-based design methods. The Static State feedback case. The Dynamic Output feedback case LPV Observer design.

Lesson 3 – Application of LPV methods for automotive systems (3H)

LPV methods for suspension control: LPV Fault Tolerant Control for suspension systems (LPV observer + qLPV fault-scheduling semi-active suspension control strategy). LPV road adaptive suspension control

LPV methods for Vehicle Dynamics: Lateral control of Autonomous vehicles. LPV FTC for Vehicle Dynamics Control.

Lesson 4– Training and validation (3H). LPV modelling of a nonlinear systems — Control of LPV systems — Observer design.

Classes will be held in the Seminar Room, Building 3, DIETI, 1st floor

Link MS-Teams:

https://teams.microsoft.com/l/channel/19%3agTWGlJ28_D-63zXG2_ASAyvpbuS9nxxD_JZ-wMjJF4M1%40thread.tacv2/General?groupId=8ff51e68-fd96-4cab-9b69-26be5c884652&tenantId=2fcfe26a-bb62-46b0-b1e3-28f9da0c45fd

Participants are requested to send an e-mail to luigi.glielmo@unina.it and Olivier.sename@grenoble-inp.fr by May 22, 2023, with the following information:
Student name and surname, name of the PhD course, PhD cycle.

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