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**: Olivier Sename received an engineering (1991) and a Ph.D. degree (1994) from Ecole Centrale Nantes. He is now Professor at Grenoble INP – UGA within GIPSA-lab. His main research interests include Linear Parameter Varying systems and automotive applications. He is the (co-)author of 4 books, around 100 international journal papers, more than 280 international conference papers and 6 patents. He was general chair of the IFAC joint conference SSSC-TDS-FDA 2013, of the 1st IFAC workshop LPVS 2015 and of the 12th ICMCE 2024 &2025. He was the IPC chair of the 2nd and 4th IFAC workshops LPVS 2018 & 2022 and the program chair ICMCE 2021&2023. He presented several plenary talks (IFAC SSSC 2019, IFAC LPVS 2021, ICMCE 2021, ICSTCC2015). He is section editor-in-chief for MDPI Electronics, 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 Linear Control Systems, Robust Control and Automotive Control. He has led several industrial (Renault, Volvo Trucks, JTEKT, Delphi) and international (Mexico, Italy, Hungary, Spain) collaboration projects. He has supervised 34 Ph.D. students.*

Credits: 4 CFU

Overview

This course is based on the recent book entitled *Linear Parameter-Varying Control: Theory and Application to Automotive Systems,* John Wiley & Sons, Inc., Hoboken, New Jersey, 2025 ISBN: 978-1-394-28595-2.
It 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. Illustration several examples wll be shown. 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 previsto (settimane 21 & 22)

Lecture	Date	Time	Topics
1	22/04/2025	10:00-13:00	Modelling & Properties of LPV systems
2	24/04/2025	10:00-13:00	LPV Control & Observation
3	28/04/2025	09:30-13:00	LPV methods for Automotive systems
4	30/04/2025	12:00-14:30	Matlab exercices
5	TBD	TBD	Assessment

Content

Lesson 1 – Modelling & Properties of LPV systems (3H). Definition of Linear Parameter Varying systems. Modelling: How to approximate a nonlinear system by an LPV one. Properties (controllability, observability). Stability analysis: quadratic stability and parameter dependent Lyapunov stability, L_2 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. Illustration of LPV design methods for non linear systems, and for adaptive-like control.

Lesson 3 – Application of LPV methods to 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 and for ADAS systems

Lesson 4– Training and validation (3H). LPV modelling of a nonlinear system — Control of LPV systems with real-time performance adaptation

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 April 18, 2025, with the following information:
Student name and surname, name of the PhD course, PhD cycle.

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