3rd ANR HANDY MEETING

2nd April 2021

2pm – 4:30pm

Zoom link https://unitn.zoom.us/j/86283451588
Meeting ID: 862 8345 1588
Passcode: 793785

PROGRAM

2pm

Pierre Riedinger (CRAN), joint work with Nicolas Blin, Jamal Daafouz, Louis Grimaud and Philippe Feyel

Necessary and sufficient conditions for harmonic control in continuous time

We revisit the concepts and tools of harmonic analysis and control and provide a rigorous mathematical answer to the following question: when does an harmonic control has a representative in the time domain? By representative we mean a control in the time domain that leads by sliding Fourier decomposition to exactly the same harmonic control. Harmonic controls that do not have such representatives lead to erroneous results in practice. The main results of this paper are: a one-to-one correspondence between ad hoc functional spaces guaranteeing the existence of a representative, a strict equivalence between the Carathéorody solutions of a differential system and the solutions of the associated harmonic differential model, and as a consequence, a general harmonic framework for Linear Time Periodic (LTP) systems and bilinear affine systems. The proposed framework allows to design globally stabilizing harmonic control laws. We illustrate the proposed approach on a single-phase rectifier bridge. Through this example, we show how one can design stabilizing control laws that guarantee periodic disturbance rejection and low harmonic content.

2:25pm

Marc Jungers (CRAN), joint work with Mathias Serieye, Carolina Albea and Alexandre Seuret

Robust stabilization to limit cycles of switching discrete-time affine systems using control Lyapunov functions

This talk deals with the robust stabilization of uncertain discrete-time switched affine systems using a control Lyapunov function approach and a min-switching state-feedback control law. After presenting some preliminaries on cycles and limit cycles, a constructive stabilization theorem is provided and guarantees that the solutions to the nominal closed-loop system converge to a limit cycle. These conditions are expressed in terms of simple Linear Matrix Inequalities (LMI), whose underlying necessary conditions relax the usual one in this literature. This method is extended to the case of uncertain systems, for which the notion of limit cycle needs to be adapted. The theoretical results are evaluated on academic examples and demonstrate the potential of the method over the recent literature.

2:50pm **Paolo Frasca (Gipsa-lab)**

On the (un)expected advantages of discontinuity in the synchronization of heterogeneous systems: open questions

Ten years ago, the work of Wieland et al. had convinced me that a common dynamical model was necessary to synchronize heterogeneous systems. To my surprise, I have recently read results that show synchronization of heterogeneous systems without apparently using any common model. How is it possible? I believe that this inconsistency originates because these positive results are based on interactions that are hybrid, or at least discontinuous, whereas interactions were assumed to be continuous by Wieland et al.

3:05pm **Coffee break**

3:25pm **Luca Zaccarian (LAAS, University of Trento)**, joint work with Nicola Zaupa, Luis Martínez-Salamero, Carlos Olalla

Hybrid self-oscillating resonant converters

A unified set of input-dependent coordinates is proposed for the description of parallel and series resonant converters. The description naturally leads to a hybrid feedback control strategy for self-oscillating behavior. We prove, through hybrid Lyapunov theory that the ensuing dynamics admits a unique almost globally attractive hybrid limit cycle. A tuning parameter, the switching angle is then numerically shown to lead to monotonic variation of the peak output current/voltage and of the self-induce switching frequency. Experimental results illustrate the desirable behavior of the self-oscillating scheme, and its robustness to unmodeled phenomena.

3:50pm **Christophe Prieur (Gipsa-lab)**, joint work with Sophie Tarbouriech

Beam equation with nested saturating inputs

This presentation deals with a controlled beam equation for which the input is subject to magnitude and rate saturations. The dynamical equation is infinite-dimensional since a partial differential equation is used to describe the dynamics of the deflection of the beam with respect to the rest position. A nonlinear dynamical controller is designed with nested saturations due to the input saturation and the rate saturation of the input. The global asymptotic stability is proven using dedicated Lyapunov theory. Some open questions conclude the presentation, with (if the time is not running too fast) some numerical simulations.