International Graduate School on Control

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Homogeneity Based Design of Sliding Mode Controllers

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The sliding mode methodology has proved to be effective in dealing with complex dynamical systems affected by disturbances, uncertainties and unmodeled dynamics. These robustness properties have also been exploited in the development of nonlinear observers for state and unknown input estimation. In conventional (first-order) sliding modes a “sliding function” (typically an algebraic function of the states) is forced to zero in finite time and maintained at zero for all subsequent time. Recently, higher-order sliding mode controllers have been developed to force the switching function and *a number of its time derivatives* to zero in finite time.

Specific features of the course

Proposed course will present a homogeneity based Lyapunov approach for the design of first-, second- and higher-order Sliding Modes Controllers (SMC), including sliding mode controllers producing continuous control signals, and some of its applications.

Outline of the course

Introduction

- Solutions of equations with discontinuous right hand sides. Finite- and fixed- time convergence
- Homogeneity, weighted homogeneity
- Lyapunov design of first-order sliding modes. Smooth and Lipschitz Lyapunov Functions. Unit Control
- Regular form. Sliding surfaces design
- Lyapunov based redesign
- Integral sliding modes

Lypunov based Second-Oder Sliding Modes Controller (SOSMC) Design

- Lyapunov-based design for twisting and terminal algorithms
- Lyapunov-based design for super-twisting controller

Lyapunov based Higher-Oder Sliding Modes Controllers (HOSMC)

-- Lyapunov- based design for HOSMC (continuous and discontinuous)

- Gain design for HOSMC. Some Alternatives:
    - Nonlinear inequalities
    - Pòlya’s theorem
    - Sum of Squares method

Sliding Mode Observation and identification

- Lyapunov-based design of arbitrary-order exact differentiators
- HOSM based robust- exact observers
- HOSM based parameter identification
- Output feedback HOSMC