Local Methods for Nonlinear Systems and Control

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Site of the Course: http://www.dei.unipd.it/ zorzimat/EECIPD/Course.pdf

Abstract of the course
Linear modeling is both the success and the limitation of engineering: local methods are analytically and computationally efficient but a thousand linearized models do not necessary account for a global phenomenon. The course will present a theory of nonlocal phenomena that can be analyzed by means of local methods, with the aim of enlarging the modeling and design principles of nonlinear control science. The emphasis will be on the role of symmetry and feedback in localizing architectures.

Topics

- **Lecture 1: Local and global analysis.**
  The principle of linearization. Review of local and global analysis methods. Motivations for local methods in global analysis. Invariance and feedback as two fundamental guidelines for local methods.
- **Lecture 2: The line, the ray, and the circle**
  Nonlinear spaces that possess efficient linearizations. Elements of differential geometry and Lie group theory. Important homogeneous spaces encountered in engineering.
- **Lecture 3: Local calculus made non local.**
  Averaging, filtering, and interpolating in nonlinear spaces.
- **Lecture 4: Local calculus made non local.**
  Differential Stability Systems that forget initial conditions. Lyapunov stability, contraction analysis, incremental stability.
- **Lecture 5: Differential Positivity.**
  Systems that preserve an order. Perron Frobenius theory. Monotonicity. Conal orders.
- **Lecture 6: Differential analysis of open systems.**
  Stability and positivity for open systems, interconnections, dissipativity.
- **Lecture7. Excitability** Locallisation by feedback. Balance between positive and negative feedback. Balance between stability and positivity. Models of excitability. Interconnections.