INSTITUTE of CYBERNETICS at TUT

Lecture Announcement

Feeback linearization with internal stability of mechanical underactuated systems

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These lectures on Nonlinear Control Theory include typical examples borrowed from Robotics which do display the limits of linearization by approximation and the necessity to tackle the nonlinearities. Non holonomic constraints are displayed for mechanical systems and related to integrability properties in mathematics. Mathematical preliminaries recall some tools from algebra and introduce the mathematical setting as well as integration theory and the related Poincaré Lemma and Frobenius Theorem.

The analysis of nonlinear control problems includes the algebraic characterization of accessibility of nonlinear control systems.

The solutions to some typical nonlinear control problems include input-output linearization for single input single output systems, via state feedback. This is also known as the computed torque method in Robotics. The limits of the method are highlightened for *non minimum phase* systems. It is shown that this method implies a maximal loss of observability and does not guaranty internal stability.
A general notion of *zero dynamics* is defined for nonlinear systems.

The special class of mechanical systems which consist of 2 degrees of freedom, 1 actuator and which are fully controllable is worked out: feedback linearization with internal stability consists in the search of some output function whose zero dynamics is asymptotically stable.

The course is illustrated by numerous examples mainly borrowed from mechanics : the car, the unicycle, the N-trailer system, robotic manipulators with or without flexibilities, the Acrobot, the Pendubot, the cart-pole system, the Ball and beam.