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Time-Delay and Sampled-Data Systems

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Abstract of the course

Time-delay appears naturally in many control systems. It is frequently a source of instability although, in some systems, it may have a stabilizing effect. A time-delay approach to sampled- data control, which models the closed-loop system as continuous-time with delayed input/output, has become popular in networked control systems (where the plant and the controller exchange data via communication network). The beginning of the 21st century can be characterized as the "time-delay boom" leading to numerous important results. The aim of this course is to give an introduction to systems affected by time-delays, in both the linear and the nonlinear framework. The emphasis of the course is on the Lyapunov-based analysis and design for time-delay, sampled-data and networked control systems.

Topics

Models of systems with time-delay and basic theory. Sampled-data and networked-control systems. LTI systems with delay: characteristic equation. Stability and performance analysis. Direct Lyapunov approach: Krasovskii and Razumikhin methods. An LMI approach to stability and performance. Control design: predictor-based control, LQR problem, LMI-based design. Stabilization by using delay. Systems with saturated actuators. Discrete-time delay systems. Networked control systems: a time-delay approach. A time-delay approach to averaging-based control. Nonlinear retarded systems with inputs: basic theory, stability, input-to-state stability. Stabilization by means of control Lyapunov-Krasovskii functionals. Universal stabilizers. Sampled-data stabilization of nonlinear retarded systems.