

Model Reduction for Control, from Linear to Nonlinear Systems

Dates and time

7-9; 14-9; 21-9; 28-9 2020
from 10.15-12.30

Course location

Online course

ECTS

3 ECTS if the homework is completed successfully. It is not possible to get ECTS for auditing. In order to get credits the homework must be completed.

Lecturers

Prof. dr.ir. J.M.A. Scherpen, University of Groningen
Prof. dr. K. Fujimoto, Kyoto University, Japan

Objective

The purpose of this course is to provide a basis for model order reduction for control based on balanced realizations, and treats the use of these methods at different levels (more in depth or more at an initial stage) for various types of systems, varying from linear to nonlinear, from lumped to networked to distributed systems.

The need for innovation results in a dominating trend towards analyzing and designing systems of increasing complexity. Such analysis and design cycles rely on the mathematical models of the systems. These models are thus increasing in complexity as well, both in nature (from linear to nonlinear, from lumped- to networked to distributed-parameter), and size. Complex models are more difficult to analyze and simulate. Due to this it is also difficult to develop and implement control algorithms; moreover high-order controllers are usually not wanted. This course will focus both on linear and nonlinear systems, and will provide a basis for studying and usage of balancing based model order reduction methods.

Contents

1. A brief overview of recent model order reduction techniques for linear and nonlinear, networks and distributed parameter systems.
2. Balancing for linear systems is treated from a state-space point of view, and a relation with minimality and the frequency domain is given. The relation with the Hankel operator, and error bounds and their derivation are treated. Other types of balancing, closed-loop balancing, and balancing based on dissipativity, and passivity will be treated.
3. Frequency weighting, controller reduction methods, and network reduction methods based on balancing will be treated.
4. Extensions to nonlinear systems for balancing and the corresponding Hankel operator will be treated.

5. Applications for linear systems, and motivational examples for nonlinear systems will be considered

Course materials

Lecture notes will be distributed during the course.

Prerequisites

Basic background in systems and control theory.

Homework assignments

Two homework sets will be handed out. The average grade will be the final grade for this course.