

M12 : LMIs in Control

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Introduction

- Overview: What can be expected from LMI techniques?
- What are LMI's and what are they good for?
- Stability: linear time-invariant, time-varying or non-linear systems
- LMI regions
- Discrete-time versus continuous-time

Performance

- Dissipativity
- Quadratic performance and specializations (H1, passivity)
- H2 performance and generalizations
- Guaranteeing hard bounds through positively invariant ellipsoids
- From nominal to robust performance

Synthesis

- State-feedback and estimation problems
- Output feedback synthesis - convexifying controller parameter transformation
- Mixed-objective control

Multi-objective control

- Youla parametrization and genuine multi-objective controller synthesis
- Robust controller design
- Parameter Elimination and Dualization

Parametric Robust Stability

- Robust stability against time-invariant and time-varying uncertainties
- Parameter dependent Lyapunov functions
- Semi-infinite LMI problems and relaxations

Robust Optimization and Lagrange Duality

- Introduction to robust optimization and robust LMI problems
- Lagrange duality
- How to construct tractable relaxations

Dynamic Robustness

- Linear fractional representations
- Robust stability tests with multipliers
- Relations to the structured singular value
- Extension to dynamic uncertainties: Integral quadratic constraints



LPV synthesis

- Linear parametrically-varying controller synthesis
- Direct approach
- Multiplier approach
- A missile example

Relaxations

- Polynomial optimization

- Lagrange relaxation and higher-order relaxations
- Robust LMI problems and testing relaxation exactness

	<p>Carsten W. Scherer earned the Ph.D. degree in mathematics from the University of Würzburg Germany) in 1991. After six months of research at the University of Groningen (The Netherlands), the University of Michigan (Ann Arbor) and Washington University (St. Louis) respectively, he joined Delft University of Technology (The Netherlands) in 1993 where he held positions as an assistant and associate professor. In fall 1999, he spent a three months sabbatical as a visiting professor at the Automatic Control Laboratory of ETH (Zurich). Since fall 2001, he is a full professor within Delft Center for Systems and Control at Delft University of Technology. His main research interests cover various topics in applying optimization techniques for developing new advanced controller design algorithms and their application to mechatronics and aerospace systems. Dr. Scherer served as an associated editor for IEEE Transactions on Automatic Control and Automatica (two terms). He is currently active on the editorial boards of Systems & Control Letters and European Journal of Control, and chairing the IFAC technical committee on Robust Control.</p>
	<p>Siep Weiland is Associate Professor at the Control Systems Group, Department of Electrical Engineering, Eindhoven University of Technology. He received both his MSc. (1986) and PhD degrees in mathematics from the University of Groningen in the Netherlands. He was a postdoctoral research associate at the Department of Electrical Engineering and Computer Engineering, Rice University, Houston, USA from 1991 to 1992. Since 1992 he has been affiliated to Eindhoven University of Technology. His research interests are the general theory of systems and control, robust control, model approximation, modeling and control of hybrid systems, identification, and model predictive control. He was Associate Editor of the IEEE Transactions on Automatic Control from 1995 to 1999, of the European Journal of Control from 1999 to 2003, of the International Journal of Robust and Nonlinear Control from 2001 to 2004 and Associate Editor for Automatica from 2003 till 2006.</p>