ME-427

Networked control systems

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Opt.
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course offers an introduction to control systems using communication networks for interfacing sensors, actuators, controllers, and processes. Challenges due to network non-idealities and opportunities offered by communication will be analyzed.

Content

Control systems relying on communication networks find several applications in emerging fields such as cyberphysical systems and the Internet of Things. The exchange of information over imperfect channels raises the problem of studying how networks impact on the real-time behaviour of systems. The first part of this course will focus on methods for analysing stability and performance of networked control systems. In the second part, instead, we will study how to exploit networked architectures for realising coordinated behaviours among subsystems. We will introduce consensus algorithms and illustrate various applications to sensor networks, cooperative robotics, analysis of opinion dynamics and electric systems.

Structure

- Review of linear systems and Lyapunov stability
- Linear matrix inequalities and switched systems
- Features of control networks
- Stability analysis of networked control systems in presence of quantization, communication delays and packet loss
- Elements of graph theory
- Discrete-time consensus algorithms
- Graph Laplacians
- Continuous-time consensus algorithms

Keywords

Communication networks, sampled-data systems, feedback control, graph theory, consensus algorithms

Learning Prerequisites

Required courses

Linear algebra, Control systems

Important concepts to start the course

- State-space models
- Linear systems in continuous and discrete time
- Basic concepts of stability
- Feedback control

Learning Outcomes

By the end of the course, the student must be able to:

- Construct and analyse a discrete-time model for a dynamic system, A5
- Analyze a multivariable dynamic system and design an appropriate controller for the system, A10
- Assess / Evaluate the stability, performance and robustness of a closed-loop system, A12
- Propose several control solutions, formulate the trade-offs, choose the options, A14
- Construct and analyse a discrete-time model for a dynamic system, A5
- Analyze a multivariable dynamic system and design an appropriate controller for the system, A10
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- Propose several control solutions, formulate the trade-offs, choose the options, A14

Transversal skills

- Use a work methodology appropriate to the task.
- Demonstrate the capacity for critical thinking

Teaching methods

Ex-cathedra, exercises

Assessment methods

Written final exam

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Bibliography

Bibliography

- Course slides on Moodle
- For the second part of the course:
F. Bullo. Lectures on Network Systems (free download)

Ressources en bibliothèque

- F. Bullo. Lectures on Network Systems

Moodle Link

- https://go.epfl.ch/ME-427