International Graduate School on Control 2020
Module M03

Eindhoven University of Technology (The Netherlands)
February 10 – 14, 2020

Networked Control of Multi-Agent Systems

Consensus and synchronisation
Communication structure design
Self-organisation in networked systems

Lecturer: **Prof. Dr.-Ing. Jan Lunze** (Ruhr-University Bochum, Germany)

Registration: www.eeci-igsc.eu
Deadline: January 12, 2020

Course summary

Networked control uses the flexibility of digital communication systems to connect arbitrary components on demand, which makes novel control structures possible and poses fundamental research questions: Under what conditions should information be transferred from one control loop to another one? What is the minimum requirement on the communication structure to solve a control problem at hand? Why are certain information structures more favourable than others?

Starting with fundamental notions of algebraic graph theory, the course shows how graph theory and systems theory have to be combined to find networked controllers that make linear agents to synchronise or to follow set-point commands collectively. It presents a novel methodology for the selection of an appropriate communication structure for which all agents react on leader commands as quickly as possible. Furthermore, it shows how the agents can generate an overall system with a reasonable structure based only on their local information such that the communication structure adapts to disturbances in a self-organised way.

The introduction of the main ideas is illustrated by numerous examples from diverse fields like vehicle platooning, networks of coupled oscillators or electrical power systems. The course participants should solve exercises, partly by using MATLAB, to learn more about the interesting dynamical phenomena that occur in networked systems.

Topics:

- Introduction to networked systems
- Algebraic graph theory
- Consensus in continuous-time and discrete-time systems
- Synchronisation of multi-agent systems with identical and individual dynamics
- Design of the communication structure of networked controllers
- Self-organisation in networked systems

Audience

The course is taught for Master students, PhD students and researchers in industry who want to understand the basic ideas of cooperative control of multi-agent systems. Prior knowledge is restricted to the basics of linear control theory. Matrix theory is extensively used.

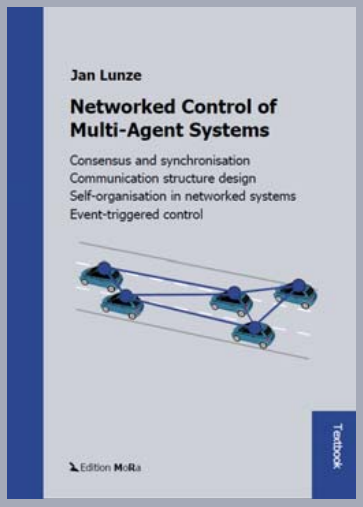
Format

21 hours of lectures and exercises. The course is eligible for 2nd Year Master Degree credits and as Scientific Thesis module. The completion of the module is awarded the equivalence of 3 ECTS (European Credit Transfer and Accumulation System).

The course uses the **new textbook**

Jan Lunze:
Networked Control of Multi-Agent Systems
BookmundoDirect 2019
ISBN 9789463867139, 715 pp., hardcover, 74.95 €

which provides more than 100 exercises, some of which will be used in the course. Furthermore, the book gives supplementary material on matrix theory, probability theory and MATLAB functions for graphs.



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Prof. Dr.-Ing. Jan Lunze is head of the Institute of Automation and Computer Control at Ruhr-University Bochum, Germany. He is the author of several textbooks on control theory, discrete-event systems and artificial intelligence. His experience with industrial applications has led to numerous examples and exercises that will be used in this graduate course to demonstrate dynamical phenomena in networked systems.

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