Ph.D. School SIDRA 2016

Distributed Control and its Applications

Coordinators: Ruggero Carli (Univ. of Padova)
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Speakers: Ruggero Carli (Univ. of Padova)
                  Marcello Farina (Polytechnic Univ. of Milan)
                  Giuseppe Notarstefano (Univ. of Salento, Lecce)
                  Luca Schenato (Univ. of Padova)
                  Sandro Zampieri (Univ. of Padova)

SCHOOL OBJECTIVES

The school has been designed with the aim to give to the PhD student a background in distributed algorithms for estimation, control and optimization for next-generation engineering systems such as Smart Cyber-Physical Systems. The main aspects that characterize distributed control systems are presented both from the theoretical and applicative perspective. Specific attention will be placed in illustrating the main mathematical tools needed in this area and in illustrating which are the most important open problems and current research avenues.

The "*Introduction to distributed control*" module will start by motivating the need for distributed algorithms with respect to different objectives (control, estimation, optimization) and different application realms (sensor networks, smart energy grids, robotic networks, traffic networks, etc..), and by illustrating the challenges that has to be faced. The Introduction will then provide an overview of the classical results on distributed and decentralized control developed in the last century (70-90's), and will touch upon the most promising approached in the last 15 years such as plug-and-play control and Distributed Model Predictive Control.

The "*Consensus – Sensor Networks*" module will introduce the main results available about the celebrated consensus algorithms that have been successfully used in many realms of control systems ranging from flocking to load balancing, from camera networks to sensor networks. In particular, several applications of these algorithms in the context of wireless sensor networks will be presented such as distributed sensor calibration, distributed parameter identification and distributed clock synchronization.

The "*Distributed optimization algorithms*" module will present some of the most popular algorithms that have been proposed recently for distributed optimization and specifically for convex distributed optimization. Particular emphasis will be placed on the mathematical machinery necessary to characterize these algorithms and on the open problems and challenges.

The "Distributed Control in Smart Grids" module will focus specifically on Smart Energy Grids. It will start by providing the necessary background and modeling

necessary to understand this engineering field and to motivate the need for distributed algorithms. Different problems will be addressed in this context as transmission loss minimization, voltage support and reactive power control.

The last module "*Distributed Control in Robotics*" will provide the main challenges posed by multi-agent robotics and the most recent approaches and results in this field to address them such as coverage, map-building and cooperative localization.

PROGRAM:

Day 1 - Thursday 14 July 2016		
h	**Topic**	**Speaker**
9.00 – 10.30	Introduction to distributed control	M. Farina
Coffee break		
11.00 – 12.30	Introduction to distributed control	M. Farina
Lunch		
15.00 – 16.30	Consensus - sensor networks	L. Schenato
Coffee break		
17.00 – 18.30	Consensus - sensor networks	L. Schenato

Day 2 - Friday 15 July 2016		
h	**Topic**	**Speaker**
9.00 – 10.30	Distributed optimization algorithms	G. Notastefano
Coffee break		
11.00 – 12.30	Distributed optimization algorithms	G. Notarstefano
Lunch		
15.00 – 16.30	Distributed control in smart grids	S. Zampieri
Coffee break		
17.00 – 18.30	Distributed control in smart grids	S. Zampieri

Day 3 - Saturday 16 July 2016		
h	**Topic**	**Speaker**
9.00 – 10.30	Distributed control in robotics	R. Carli
Coffee break		
11.00 – 12.30	Distributed control in robotics	R. Carli