UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Optimal Control: From Calculus of Variations Theory to Numerical Optimization Methods and Tools, with Application to Motion Planning and Control**"**

Manolo Garabini

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Short Abstract:

The availability of an unprecedented level of computational power opens a whole new range of possibilities in several fields. This is strongly impacting the way to plan and control the motion of robots. This course will provide an approach to exploit the full potential of these new tools starting from the calculus of variations theory and then showing how to properly translate an optimal control problem into an optimization program. Hence an overview of the state-of-the-art optimization algorithms (and tools) will be given highlighting the link between different algorithms and problems. Finally examples and open problems will be discussed.

Course Contents in brief:

1. Introduction (0.5 h)
2. Elements of Calculus of Variations (3 h)
3. From Optimal Control to Optimization (3.5 h)
4. Optimization Problems (3.5 h)
5. Deterministic Optimization Algorithms (3.5 h)
6. Tools, Solvers and the Decision Tree (3.5 h)
7. Examples (3.5 h)
8. Open Problems in Motion Planning and Control of Robots (3 h)

Total # of hours: 24

References:

Bryson, A. E., and Yu-Chi Ho. "Applied optimal control. 1969." Blaisdell, Waltham, Mass 8 (1969): 72.

Boyd, Stephen, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.

Decision Tree for Optimization Software http://plato.asu.edu/guide.html
Floudas, Christodoulos A. Deterministic global optimization: theory, methods and applications. Vol. 37. Springer Science & Business Media, 2013.

CV of the Lecturer

Manolo Garabini graduated in Mechanical Engineering and received the Ph.D. degree in Robotics from the University of Pisa where he is currently employed as Assistant Professor. His main research interests are in the design, planning and control of soft and adaptive robots, from single joints, to end-effectors (hands, grippers, feet), to complex multi-d.o.f. systems. A part of his activity has been devoted to theoretically demonstrate the effectiveness of soft and adaptive robots in high performance, high efficiency and resilient tasks via analytical and numerical optimization tools. He contributed to the realization of modular Variable Stiffness Actuators: the VSA-Cube. He contributed in the design of the joints and the lower body of the humanoid robot WALK-MAN and took part at the DARPA Robotics Challenge and at a field test in Amatrice, Italy after a disastrous earthquake event. Recently he contributed to the development of an efficient and effective compliance planning algorithms for interaction under uncertainties, and to derive a minimum-time motion planning algorithm for jerk-controlled robots. Currently he is the local Principal Investigator in the European Research Project THING, within the H2020 framework, for the University of Pisa, the coordinator of the project Dysturbance, subproject of the European Research Project Eurobench, within the H2020 framework.

Room

Online

Schedule

Monday 27 – Friday 31 July 2020

Mon	Tue	Wed	Thu	Fri
	8:30 10:30	8:30 10:30	8:30 10:30	9:00 10:30
	Break	Break	Break	Break
	11:00 12:30	11:00 12:30	11:00 12:30	11:00 12:30
Lunch				
13:30 15:30	13:30 15:30	Lab Visit	13:30 15:30	
Break	Break		Break	
16:00 17:30	16:00 17:30		16:00 17:30	