

# Model Predictive Control and Applications

**Duration:** 18 hours

**Teacher:** Mauro Gaggero – ISSIA, National Research Council (CNR), Genova - mauro.gaggero@cnr.it

**When:** March 21-25, 2016

**Where:** DIBRIS - Via Dodecaneso, 35

## Abstract

Model predictive control (MPC) is a control paradigm that has been widely employed in the literature owing to its ability to exploit information on the future behavior of the system to control, its capability of dealing with constraints, and the presence of many theoretical results about its properties. From various decades, MPC has been used for process control in chemical plants, and nowadays it is employed for controlling also other complex setups such as, for example, power plants, mechatronic systems, logistics operations, cloud computing applications, and so on. It is still receiving on-going interest from researchers in both the industrial and academic communities. The course will start from the basic theoretic notions of MPC, together with recent developments in design and implementation. Special attention will be devoted to the computational aspects of MPC and to the existing techniques to reduce the overall required effort. An overview of receding-horizon state estimation, a topic strictly related to MPC, will be given as well. Finally, recent applications of MPC will be presented, together with details of their software implementation.

## Program

- Introduction to discrete-time model predictive control
- Model predictive control with constraints
- Model predictive control and stability analysis
- Moving-horizon state estimation
- Real-time implementations of model predictive control
- Examples of applications of model predictive control

## References

- M. Morari, J.H. Lee, "Model predictive control: past, present and future", *Computers and Chemical Engineering*, vol. 23 pp. 667-682, 1999.
- D. Mayne, J. Rawlings, C. Rao, and P. Scokaert, "Constrained model predictive control: stability and optimality," *Automatica*, vol. 36, no. 6, pp. 789–814, 2000.
- E.F. Camacho, C. Bordons, "Model Predictive Control", *Series Advanced Textbooks in Control and Signal Processing*, Springer, 2004.
- L. Wang, "Model Predictive Control System Design and Implementation Using MATLAB", *Series Advances in Industrial Control*, Springer, 2009.
- A. Alessandri, M. Baglietto, G. Battistelli, M. Gaggero, "Moving-horizon state estimation for nonlinear systems using neural networks," *IEEE Transactions on Neural Networks*, vol. 22, no. 5, pp. 768-780, 2011.
- A. Alessandri, M. Gaggero, F. Tonelli, "Min-max and predictive control for the management of distribution in supply chains," *IEEE Transactions on Control Systems Technology*, vol. 19, no. 5, pp. 1075-1089, 2011.
- A. Alessandri, C. Cervellera, M. Gaggero, "Nonlinear predictive control of container flows in maritime intermodal terminals," *IEEE Transactions on Control Systems Technology*, vol. 21, no. 4, pp. 1423-1431, 2013.
- A. Alessandri, M. Gaggero, F. Tonelli, "Robust predictive control for the management of multi-echelon distribution chains," *Proceedings of the 53rd IEEE Conference on Decision and Control*, Los Angeles, USA, 2014, pp. 6459-6464.
- M. Gaggero, L. Caviglione, "A predictive control approach for energy-aware consolidation of virtual machines in cloud computing," *Proceedings of the 53rd IEEE Conference on Decision and Control*, Los Angeles, USA, 2014, pp. 5308-5313.