Introduction to Model Predictive Control with Case Studies in Automotive and Biomedicine

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Timetable: 20 hrs. (see Class Schedule on https://phd.dei.unipd.it/course-catalogues/)

Course requirements: Basic Calculus and Linear Algebra.

Examination and grading: Homework and take home exam

SSD: Information Engineering

Aim: To provide the methodological tools needed to understand model-based control algorithms and to design a Model Predictive Control algorithm for a linear dynamical system. The course is tailored on students who have not received an extensive training on control theory. As case studies, the course focus on Automotive and Bioengineering applications.

Course contents:

1. Introduction to model-based control.
2. State Space Models: driving the state with inputs.
3. State Space Model: estimating the state form the output.
4. Linear Quadratic Regulator (finite and infinite horizon).
5. Model Predictive Control - Regulation: Formulation, Dynamic Programming Solution, Stability properties, MPC for Unconstrained Systems, MPC for Systems with Input Constraints, MPC for Systems with Input and State Constraints.
6. Offset-free Model Predictive Control: disturbance estimation, partial velocity form, full velocity form.
7. Elements of Nonlinear MPC.
8. Automotive case studies: Motion Cueing Algorithms, Virtual Rider, Autonomous Driver.
9. Biomedicine case study: the Artificial Pancreas, Automated Drug Infusion for Anesthesia.

References:

[1] J. B. Rawlings and D. Q. Mayne. Model predictive control: Theory and design. Nob Hill Publisher.

Other material and research papers will be available online for download.