University of Kurdistan
Department of Electrical Engineering

Model Predictive Control

(Spring 2020)

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Course Description

Model predictive control (MPC) is the class of advanced control techniques applied to ranging from the process industry to the automotive and power systems. The advantage is that MPC can deal with almost any time-varying process, multivariable systems with time-delays, constraints and specifications, limited only by the availability of real-time computational power.

MPC was developed in the process industries in the 1960's and 70's, based primarily on heuristic ideas and input-output step and impulse response models. The basic principle is to solve an open-loop optimal control problem at each time step. The decision variables are a set of future manipulated variable moves and the objective function is to minimize deviations from a desired trajectory; constraints on manipulated, state and output variables are naturally handled in this formulation. Feedback is handled by providing a model update at each time step, and performing the optimization again.

The primary objective of the course is to provide an introduction to the theory and application of model predictive control (MPC).

Topics Covered

1. Introduction to Model Predictive Control
   - Brief history
   - State of the art
   - Theoretical status
   - Pros and Cons
2. Fundamentals of optimization: review of linear/ quadratic programming
3. Linear MPC Theory: feasibility, stability, performance
4. Other MPC Strategies: Nonlinear MPC, Hybrid MPC, Stochastic MPC, …
5. MPC Applications
6. Future directions

Grading

The course grade will be determined using the following:

- Homework and Activities: 10%
- Presentation of a Recent Work: 15%
- Final Exam: 35%
- Final Project: 40%

References

[1] Q. Shafiee, *Course Lecture Notes*, Spring 2019.
[2] Model Predictive Control, by E.F. Camacho & C. Bordons,
[3] Model Predictive Control System Design and Implementation Using MATLAB, by Liuping Wang,
[4] Model Predictive Control: A practical approach, by J. A. Rossiter,
[5] Model Predictive Control: Theory and Design, by James B. Rawlings, and David Q. Mayne,
[6] Predictive Control with Constraints, by J. M. Maciejowsk,

Homework Assignments

Throughout the course the students will have to solve a number of home assignments. The homework assignments will be performed along the semester.
Note: Students may discuss the problems with other students, but are not allowed to share solutions (MATLAB m-files, etc.).

Final Project

Number of recent published IEEE Transactions in the field of Model Predictive Control will be provided. You can choose among them and work on a paper of your choice. You must make sure that you do not choose the same topic as the other students. During the last 1/2 of this course, you will present the selected paper. This will give you a chance to deepen your knowledge in your area of interest. Around 10 minutes is given to each student to present his/her project-work to the rest of the class.

For the final project, you should either regenerate the paper (using simulation in Matlab) or use the problem stated in the paper, and try to improve the drawbacks of the work using the knowledge you earn during the course. Finally, you should provide a detailed written report and sent it to q.shafiee@uok.ac.ir. You may be asked to present your work in person in case needed.