Model Predictive Control: Design and Implementation Using MATLAB®

Workshop Outline

Model Predictive Control (MPC) has a long history in the field of control engineering. It is one of the few areas that has received ongoing interest from researchers in both the industrial and academic communities. Four major aspects of model predictive control make the design methodology attractive to both engineers and academics. The first aspect is the design formulation, which uses a completely multivariable system framework where the performance parameters of the multivariable control system are related to the engineering aspects of the system; hence, they can be understood and 'tuned' by engineers. The second aspect is the ability of method to handle both 'soft' constraints and hard constraints in a multivariable control framework. This is particularly attractive to industry where tight profit margins and limits on the process operation are inevitably present. The third aspect is the ability to perform process on-line optimization. The fourth aspect is the simplicity of the design framework in handling all these complex issues.

This one-day short course gives an introduction to model predictive control, and recent development in design and implementation. Beginning with an overview of the field, the course will systematically cover topics in optimization, receding horizon control, constrained control, switched linear model predictive controller for periodic exogenous signals, prescribed degree of stability, tuning of predictive controller for complex systems, as well as real-time simulation and implementation using MATLAB® and Simulink® as a platform. The course, based on a predictive control book by the speaker, is suitable for engineers, students and researchers who wish to gain knowledge about model predictive control, as well as understand how to perform real time simulation and implementation using MATLAB and Simulink tools.

Workshop Schedule

8:30-10:30: Introduction to Model Predictive Control
Course overview; state-space models; design formulation using velocity form model, receding horizon control, implementation using an observer, implementation without using an observer, MPC design using Laguerre functions.

10:30-10:45 Coffee Break

10:45-12:30 Predictive Control with Constraints
Formulation of the constrained control problem; quadratic programming, solution to the constrained control problem using a quadratic programming algorithm.

12:30 – 1:30 Lunch Break

13:30-14:30 Predictive Controller for periodic exogenous signals
Frequency decomposition of periodic reference signals, internal model principle, predictive controller for periodic exogenous signals.

14:30-16:30 Predictive Control System with Prescribed Degree of Stability
Use of exponential data weighting, numerically well-conditioned algorithms, prescribed degree of stability, tuning of predictive controller for a complex system.

16:00-16:15 Coffee Break

16:15-17:30 Real Time Simulation and Implementation of Model Predictive Control
Real time simulation using MATLAB and Simulink, real time implementation using xPC Target, implementation of MPC on a DC motor.
About the Speaker

Liuping Wang received her PhD in 1989 from the University of Sheffield, UK; subsequently, she was an adjunct associate professor in the Dept. of Chemical Engineering at the University of Toronto, Canada. From 1998 to 2002, she was a senior lecturer and research coordinator in the Center for Integrated Dynamics and Control, University of Newcastle, Australia before joining RMIT University where she is a professor and Head of Discipline of Electrical Engineering. She is the author of two books, joint editor of one book, and has published over 130 papers.

Liuping Wang has been actively engaged in industry-oriented research and development since the completion of her PhD studies. Whilst working at the University of Toronto, Canada, she was a co-founder of an industry consortium for the identification of chemical processes. Since her arrival in Australia in 1998, she has been working with Australian government organisations and companies in the areas of food manufacturing, mining, automotive and power services, including Food Science Australia, Uncle Ben’s Australia, CSR, BHP-Billiton, Pacific Group Technologies, Holden Innovation, Alinta, and ANCA. She leads the Control Systems program at the Australian Advanced Manufacturing Cooperative Research Center (AMCRC) that develops next generation technology platforms for the manufacturing industry. She is also on the Board of Directors of the Australian Power Academy that promotes power-engineering education and raises scholarships from the power industry to support undergraduate students.