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 on-going interest from researchers in both the industrial and academic communities. Three 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.

This one-day short-course gives an introduction to model predictive control, and recent developments in design and implementation. Beginning with an overview of the field, the course will systematically cover topics in optimization, receding horizon control, MPC design formulations, constrained control, as well as real-time simulation and implementation using MATLAB® and Simulink® as a platform. The simulation and implementation procedures are demonstrated on a laboratory apparatus. The course is suitable for engineers, students and researchers who wish to gain basic 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 and design formulation using a general state space model; state estimation; a case study on food extruder.

10:30-11:00 Coffee Break

10:45-12:30 Further topics in Model Predictive Control

Exponential data weighting in MPC design with guaranteed stability margin and numerically well-conditioned algorithms; MPC design using Laguerre functions; Equivalence between MPC and Linear Quadratic Regulator (LQR).

12:30 – 1:30 Lunch Break

13:30-15:30 Constrained Model Predictive Control

Formulation of the constrained control problem; solution to the constrained control problem using a quadratic programming algorithm.

3:30-4:00 Coffee Break

15:45-17:30 Real Time Simulation and Implementation of Model Predictive Control on a Laboratory Apparatus

Real time simulation using MATLAB and Simulink; real time implementation using xPC Target; experimental test.

About the Speaker

Professor Liuping Wang received her Ph.D degree in 1989 from the Department of Automatic Control and Systems Engineering, University of Sheffield, UK. Upon completion of her PhD degree, she worked in the Department of Chemical Engineering at the University of Toronto, Canada for eight years in the field of process control. From 1998 to 2002, she worked in the Center for Integrated Dynamics and Control, University of Newcastle, Australia. In February 2002, she joined the School of Electrical and Computer Engineering, RMIT University, Australia where she is a Professor of Control Engineering and the Head of Discipline for Electrical Energy and Control Systems. She has authored and co-authored more than 100 scientific papers in the field of system identification, PID control, adaptive control, model predictive control, and control technology application to industrial processes. She co-authored a book with Professor Will Cluett entitled *From Process Data to Process Control- Ideas for Process Identification and PID control* (Taylor and Francis, 2000). More recently, she co-edited a book with Professor Hugues Garnier entitled ' *Continuous time model identification from sampled data*' (Springer-Verlag, 2008). Her new book entitled ' *Model Predictive Control Design and Implementation using MATLAB®'* will be published by Springer-Verlag in later 2008. Dr Liuping Wang has successfully applied the predictive control technologies to food extruders, automotive brake-by-wire systems, and magnetic bearing systems.