Predictive Control of Interconnected Machines

Abhishek Dutta

Supervisor(s): Robain De Keyser

I. Introduction

Model Predictive Control (MPC) is well studied technique for slowly varying chemical plants. Mechatronic systems on the other hand pose challenges like faster, uncertain and time varying dynamics of closely coupled subparts. Three novel MPC architectures are proposed for such series connected systems.

II. Methodology

A series interconnection of two subsystems of a machine is considered, for instance a wet-clutch with separately identified models for current to pressure and pressure to position of an engagement. Additional conditional logic on such structure leads to hybrid dynamics.

First method computes input which drives the entire system into one piecewise continuous region, followed by merger of input/output disturbances by graphical move sum approach, thus enabling series connection of transfer functions for MPC of this reduced system. For the MPC formulations, please refer [1].

The Mixed Loop Predictive control (MLPC) first generates inputs offline for the outer loop based on the overall set-point. The inputs in turn are used for tracking by the inner loop thus producing control inputs for the machine with online feedback. This second approach is powerful tool as in principle both the loops can be under different control schemes. The results from a wet clutch engagement are plotted in fig.1 where the MPC tracks an Iterative Learning Controller.

Prismatic movements in mechanics like of shafts can be marginally stable, rediscretization of the subsystem model with bigger sampling time leads to desired loop shaping of response. This forms the outer loop of Cascade Predictive Control (fig.2). The inner closed loop executes at the original higher system frequency. The outer loop must be robust towards plant-model mismatch. These are marked differences of this third technique with the classical cascade control scheme.

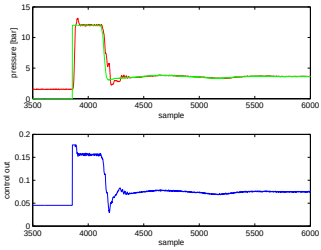

Figure 1. Pressure(red)+profile(green),current(blue)

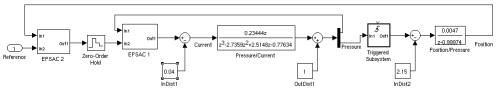

Figure 2. Predictive Cascade Control

III. Conclusions

MPC is formalized for interconnected systems and demonstrated on production machines.

Acknowledgments

This research is supported by IWT-SBO project LeCoPro (grant nr. 80032).

References

[1] A. Dutta et. al., *Predictive control for non-strictly proper and non-causal systems*, 29th Benelux Meeting on Systems and Control, Netherlands, March'2010.