Tuning linear Model Predictive Controllers. The dependence on the sampling interval

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Abstract: Model Predictive Control is a control methodology that uses a model of the plant to be controlled in order to predict its output over a future horizon. At each time instance a control sequence is calculated online as the solution to an open-loop control problem based on the model, the current state and specified reference trajectory. Only the first element of the control sequence is applied to the system and feedback is obtained by repeating this procedure when the next measurements are received.
Solving the open-loop control problem involves finding a minimizer of some (potentially constrained) optimization problem. The cost function will typically be a weighted sum of terms serving each their purpose. One term will penalize the deviation of output from the reference trajectory while another will seek to impose on the input some property such as smoothness or minimum power spent. The question of how to weight these competing cost function terms relative to each other in order to obtain the desired control performance is part of the tuning problem of MPC.
The plant model entering into the optimization problem is typically obtained by discretizing some continuous-time model cast in terms of differential equations. The discretization introduces a dependence on the sampling time. This immediately gives rise to at least two questions. One is what happens to the minimizers of the open-loop control problems as one lets the sampling time tend to zero. What relation - if any - do these minimizers bear to the original continuous-time model ? Another question pertains to the weighting coefficients in the cost functional. What is the mutual relationship - if any - of weighting parameters obtained by tuning for different sampling intervals and do they bear any relation to some underlying continuous-time problem formulation ? In a recent work the authors have addressed these two questions in the case of linear plant models. The results given in this presentation will give a brief view of what it entails to prove such results rigorously and primarily dwell on the practical implications for the tuning of MPC.

Keywords: predictive control, model-based control, MPC tuning, discretization of control problems

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