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Variational data assimilation for POD based MPC

For many problem settings, the underlying dynamics can be described by (systems of) ordinary or partial differential equations based on physical laws and equations. However, many practical applications require highly sophisticated models, which are often impractical for numerical computations due to their complexity. For this reason, model simplifications are often carried out leading to model errors. Moreover, in many practical settings, there are unknown quantities (e.g. parameters, boundary conditions etc.) which leads to a further source of errors (model uncertainty).
Apart from the physical model of the considered problem setting, a different source of knowledge of the dynamical behavior is measurement data. However, measurement data is often limited, because it is usually expensive to take or only partially (or even not) available.

The concept of variational data assimilation aims to find a best compromise between the physical model and the measurement data. The advantage of this approach is that the resulting numerical solution not only complies with the physics of the system but also is close to the measurements.

In this talk, we develop a variational data assimilation approach for POD based model predictive control (MPC). In particular, we are concerned with an optimal control problem with a very large (or even infinitely large) time horizon, which is tackled within MPC by splitting the time domain into a sequence of smaller time horizon problems and solving open-loop problems. Since the solution of the open-loop MPC subproblems can be an expensive task, we solve POD surrogates instead. After each MPC iteration, we incorporate measurement data into the POD reduced-order model using ideas of variational data assimilation in order to get closer to the reality.

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