Stability of MPC based on data-driven input/output models

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Model predictive control (MPC) requires a sufficiently accurate prediction model of the system under control. The use of data-driven surrogate models gained increasing popularity in the last years supported by many powerful learning methods. In many practical applications, however, the system state is not directly measurable and data-driven models have to be constructed based on input/output measurements. In [1], an MPC formulation without terminal conditions with output-weighting stage cost can be considered, which is only positive semi-definite with respect to the state. Consequently, standard stability results based on positive-definite stage costs cannot be applied directly and detectability properties have to be taken into account [2].
We construct a suitable storage function to establish cost detectability and, in combination with cost controllability, derive exponential stability for sufficiently long prediction horizons assuming exponential stabilizability and proportional approximation error bounds, building on the results in [3, 4].
Moreover, we verify the imposed conditions on the approximation using kernel interpolation and demonstrate the practical applicability to nonlinear systems by numerical simulations.

Literatur

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