Multirate MVC design and control performance assessment: A data-driven subspace approach

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Abstract

In many industrial applications, control signals and output measurements need to be sampled at different rates, leading to multirate systems. This paper discusses the minimum variance control (MVC) design and the control performance assessment based on the MVC-benchmark for multirate systems. In particular, a system with a fast control updating rate and a slow output sampling rate is considered, which is common in industry. A lifted model is used to analyze the multirate system in a state-space framework. The lifting technique is used as an alternative to derive a subspace equation. This subspace equation, a well-known concept in subspace identification theory, is used for the development of the multirate MVC law, and the algorithm to estimate the multirate MVC-benchmark variance or performance index. The multirate optimal controller is calculated from a set of input/output open-loop experimental data. This approach is data-driven since it does not involve solving Diophantine or Riccati equations (as in the traditional MVC design) and does not even involve a parametric model. The presented MVC-benchmark variance estimation algorithm requires a set of open-loop experimental data and close-loop routine operating data. This algorithm is model-free because no prior knowledge, namely, transfer function matrices, Markov parameters or interactor matrices, are needed (as in traditional control performance assessment algorithms). The proposed methods are illustrated through a simulation example.

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