Dynamic parameter estimation and prediction over consecutive scales, based on moving horizon estimation - applied to an industrial cell culture seed train

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Abstract

Bioprocess modeling has become a useful tool for prediction of the process future with the aim to deduce operating decisions (e.g. transfer or feeds). Due to variabilities, which often occur between and within batches, updating (re-estimation) of model parameters is required at certain time intervals (dynamic parameter estimation) to obtain reliable predictions. This can be challenging in the presence of low sampling frequencies (e.g. every 24 hours), different consecutive scales and large measurement errors, as in the case of cell culture seed trains. In this contribution, two estimation techniques, which differ in terms of their objective functions, were investigated regarding robustness concerning the aforementioned challenges and the required amount of experimental data (estimation horizon). A common weighted least squares estimation (WLSE) and a moving horizon estimation (MHE), which takes prior knowledge about model parameters into account, were applied for re-estimation of model parameters over three consecutive cultivation scales (40 - 2,160 L) of an industrial cell culture seed train. It is shown how the proposed MHE can deal with the aforementioned difficulties by integration of prior knowledge, even if only data at two sampling points are available, outperforming the classical WLSE approach. A workflow illustrating the required steps is presented.

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