

Online parameter reconstruction for bilinear control systems with applications to MRI

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We are interested in a parameter reconstruction problem emerging from MRI applications : consider a bilinear parabolic PDE of the form $\dot{z}^* + H_0(\theta^*, z^*) + C(q, z^*) = H_1\theta^*$, where the state $z^*(t, x)$ is subject to the action of a control $q(t, x)$ and of an unknown time-independent parameter $\theta^*(x)$. Assuming partial state observations, we aim at reconstructing the parameter $\theta^*(x)$.

To do so, we introduce an online reconstruction method in the spirit of the works of Baumeister et al. [1] and Kügler et al. [2] : considering on time-dependent state and parameter estimates $z(t, x)$ and $\theta(t, x)$ evolving under the combined action of observation-based numerical controls and of a carefully designed physical control $q^*(t, x)$, we prove their convergence towards the true state and parameters.

The setting described above comprises a model based quantitative MRI setting, where one seeks to reconstruct spin density and relaxation times in the Bloch(-Torrey) equation with the pulse sequence as a control.

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- [1] J. Baumeister, W. Scondo, M. Demetriou, I. Rosen. *On-line parameter estimation for infinite-dimensional dynamical systems*. SIAM Journal on Control and Optimization, **35**, 678–713, 2006. doi :10.1137/S0363012994270928.
- [2] R. Boiger, B. Kaltenbacher. *An online parameter identification method for time dependent partial differential equations*. Inverse Problems, **32(4)**, 045006, 2016. doi :10.1088/0266-5611/32/4/045006.