Model Order Reduction for Parametric Dynamical Systems with Guaranteed Error Bounds

TECHNISCHE UNIVERSITÄT DARMSTADT

Master‘s Thesis

In the context of global parameter tuning of structured controllers in large-scale systems, the exchange of tailored reduced-order models was recently proposed [1]. While many model reduction methods exist, parameter-dependent model order reduction remains challenging.

In this thesis, different parametric model order reduction techniques will be investigated, implemented, and compared. A special focus is the analysis and development of guaranteed error bounds.

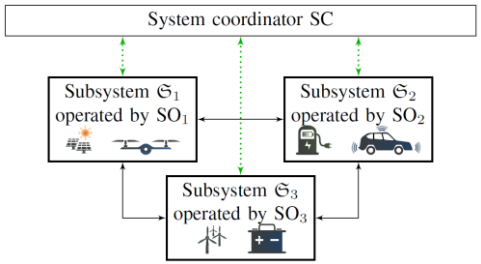
First, a basic understanding of both the parameter tuning for large-scale systems [1] and the existing analysis framework is to be developed. Next, extensive literature research regarding parameter-dependent model reduction will be conducted [2].

The methods are to be implemented in Matlab or Python. Their respective advantages and disadvantages will be compared by considering an example system.

Lastly, by using robust control theory, the $\mathcal{H}_\infty$ error bounds of the methods must be investigated. In [3], convex programming was applied to stabilize a reduced-order model. By expressing the error bound as a linear matrix inequality, this result poses a possible starting point toward incorporating error specifications into the design of the reduced-order model.

Basic knowledge of control theory and optimization is required.

Please do not hesitate to contact me if you have any further questions!



[1] A. Mešanović, U. Münz, and R. Findeisen, "Scalable and Data Privacy Conserving Controller Tuning for Large-Scale Power Networks," in *IEEE Transactions on Control Systems Technology*, vol. 30, no. 2, pp. 696-711, 2022

[2] P. Benner, S. Gugercin, and K. Willcox, “A Survey of Projection-Based Model Reduction Methods for Parametric Dynamical Systems,” *SIAM Review,* vol. 57, no. 4, pp. 483-531, 2015.

[3] D. Amsallem and C. Farhat, “Stabilization of projection-based reduced-order models,” International Journal for Numerical Methods in Engineering, vol. 91, no. 4, pp. 358-377, 2012.

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