

Model Reduction of Quadratic Bilinear Descriptor Systems using Parametric Reduction Techniques with Error Estimation

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We propose an interpolation based projection framework for model reduction of quadratic bilinear descriptor systems. The approach represents the bilinear part of the original quadratic bilinear descriptor system into a linear system with affine parameter dependence and identifies projection matrices from the linear parametric system. Two different approaches are used to map the bilinear system into a linear parametric system. One is based on simply treating the input as a parameter and the other is linked to the selection of weights in the Volterra series interpolation [1]. The main purpose of mapping a bilinear system as a linear parametric system is to utilize the error estimation techniques derived recently in [2]. This allows us to select a good choice of interpolation points and parameter samples for the construction of the projection matrices by employing the error estimator in a greedy type framework. The results are compared with the standard quadratic bilinear projection methods [3, 4] and it is observed that the approximations through the proposed methods are comparable to the standard method. An advantage of the proposed method is that the computations associated with the quadratic term in the construction of the projection matrices can be saved.

References

- [1] G. Flagg and S. Gugercin. Multipoint Volterra Series Interpolation and \mathcal{H}_2 Optimal Model Reduction of Bilinear Systems. Accepted to appear in SIAM J. Matrix Anal. Appl., 2015. Available as arXiv:1312.2627.
- [2] L. Feng, A. C. Antoulas and P. Benner. Some a posteriori error bounds for reduced order modelling of (non-)parameterized linear systems. Technical report (2015).
- [3] C. Gu. QLMOR: a projection-based nonlinear model order reduction approach using quadratic-linear representation of nonlinear systems. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems. 30-9 (2011), 1307–1320.

- [4] P. Benner and T. Breiten. Two-sided projection methods for nonlinear model order reduction. *SIAM J. Sci. Comput.*, 37-2 (2015), B239–B260.