Error Estimation in Frequency Domain and its Use for Model Reduction of Quadratic Bilinear Systems

M. I. Ahmad[1], L. Feng[1], and P. Benner[1]

[1]Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany

We consider interpolatory techniques for model reduction of quadratic bilinear systems. The input-output representation of these nonlinear systems in frequency domain involves multivariate generalized transfer functions, each representing a subsystem of the original system. Existing interpolatory techniques [3, 1] for model reduction of quadratic bilinear systems interpolate these generalized transfer functions at some random set of interpolation points or by using the corresponding linear iterative rational Krylov algorithm. The goal here is to propose an approach that identifies a good choice of interpolation points based on the error bound expressions derived recently in [2]. We extend the use of error estimators to quadratic bilinear systems by identifying error bounds for the generalized transfer functions. This allows us to iteratively update the interpolation points in a predefined sample space by selecting the points corresponding to the maximal error bound. The approach results in a greedy type algorithm for model reduction of the generalized transfer functions and therefore for the quadratic bilinear system. Numerical results show the importance of choosing the interpolation points for some benchmark examples.

References

[1] P. Benner and T. Breiten. Two-sided projection methods for nonlinear model order reduction. *SIAM Journal on Scientific Computing*, 37(2):B239–B260, 2015.

[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):1307–1320, 2011.