A Time-domain Approach for the Choice of the Interpolation Point in Moment Matching

R. Eid, B. Salimbahrami, B. Lohmann

Lehrstuhl für Regelungstechnik, Technische Universität München
Boltzmannstr. 15, D-85748 Garching bei München,
Tel: +49(0)89/28915592, E-Mail: eid@tum.de

The well-known problem of finding a suitable interpolation point in order reduction via moment matching is investigated from a time-domain perspective.

Lately, several successful methods for approximating the impulse response using orthogonal polynomials have been proposed. Among these approaches, the Laguerre-based reduction has shown to be very suitable for the reduction of large-scale systems as it can be reformulated to benefit from the numerical and computational advantages of the Krylov subspace-based methods. However, to optimize this time-domain approximation, the choice of the Laguerre pole, also known as time-scale factor, is crucial and has been treated in several works, e.g. [3].

Now, by using the equivalence property of moment matching and Laguerre-based order reduction, both in time- and frequency-domain [1, 2], the open problem of choosing an *optimal* expansion point in the rational Krylov subspace reduction methods (moment matching about $s_0 \neq 0$) can be reformulated to the problem of finding the *optimal* parameter α in the Laguerre-based reduction methods.

In this talk, it is first shown that the key parameter for the impulse response approximation of the original system can be calculated optimally in a closed-form by solving appropriate Lyapunov equations. Then, two methods for the choice of the *optimal* Laguerre parameter and consequently the single expansion point in rational interpolation order reduction are presented. Accordingly, different model reduction algorithms are suggested and their advantages and disadvantages are pointed out. The importance of these approaches lies in the fact that they try to minimize the effect of the higher order terms in the infinite Laguerre series expansions of the impulse response, and that they offer a time-domain interpretation of moment matching which is originally developed in frequency domain. In addition, the methods have a simple structure and are numerically efficient and thus suitable for the reduction of large-scale systems.

[1]R. Eid and B. Lohmann. Moment matching model order reduction in time domain via laguerre series. In *Proc. IFAC World Congress*, Seoul, South Korea, 2008.

[2]R. Eid, B. Salimbahrami, and B. Lohmann. Equivalence of laguerre-based model order reduction and moment matching. *IEEE Trans. on Automatic Control*, 52(6):1104–1108, 2007.

[3]Y. Fu and G. A. Dumont. An Optimum Time Scale for Discrete Laguerre Network. *IEEE Transactions on Automatic Control*, 38(6):934–938, June 1993.