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AN OVERVIEW OF BALANCING ORDER REDUCTION TECHNIQUES USING THE METHOD OF SINGULAR PERTURBATIONS AND NEW ALTERNATIVE TECHNIQUES

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Abstract. In this paper an overview of balancing order reduction techniques based on singular perturbations known as residualization and generalized residualization is presented and some alternative techniques are introduced. The alternative techniques can improve the accuracy of the residualization and generalized residualization techniques used for system order reduction at low and medium frequencies. Theoretically, the newly introduced methods and those already existing in the literature have the same upper error bound. A practical comparative analysis among these techniques is done using simulation on mathematical models of real physical systems. In some cases, the newly introduced techniques outperform both the residualization and generalized residualization techniques. In addition, we review the order-reduction technique known as reverse residualization, which is very well suited for system approximation at high frequencies, and present the corresponding simulation results.

Keywords. System balancing, robust system order reduction, residualization, generalized residualization, and singular perturbations.

AMS (MOS) subject classification: This is optional. But please supply them whenever possible.

1 System Order Reduction via System Balancing

The problem of reducing the order of a dynamic system (the number of differential/difference equations that describe the system's dynamic behavior) dates back to the sixties, when system order reduction was studied in terms of the system's eigenvalues. One of the very popular system order reduction techniques is based on the concept of system's dominant eigenvalues. It is well known that if a system has a pair of complex conjugate eigenvalues close to the imaginary axis with all remaining eigenvalues being stable and located far from the imaginary axis, then the system's dynamic behavior can be approximated by using only a second-order model. This idea is generalized in the so-called theory of singular perturbations (Kokotovic et al., 1986), where