Simulating swing dynamics of a power system model using nonlinear model order reduction

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Abstract

Purpose – The purpose of this paper is to demonstrate the applicability of the Discrete Empirical Interpolation method (DEIM) for simulating the swing dynamics of benchmark power system problems. The authors demonstrate that considerable savings in computational time and resources are obtained using this methodology. Another purpose is to apply a recently developed modified DEIM strategy with a reduced on-line computational burden on this problem.

Design/methodology/approach – On-line computational cost of the power system dynamics problem is reduced by using DEIM, which reduces the complexity of the evaluation of the nonlinear function in the reduced model to a cost proportional to the number of reduced modes. The on-line computational cost is reduced by using an approximate snap-shot ensemble to construct the reduced basis.

Findings – Considerable savings in computational resources and time are obtained when DEIM is used for simulating swing dynamics. The on-line cost implications of DEIM are also reduced considerably by using approximate snapshots to construct the reduced basis.

Originality/value – Applicability of DEIM (with and without approximate ensemble) to a large-scale power system dynamics problem is demonstrated for the first time.

Keywords Reduced-order method, Model order reduction, Discrete empirical interpolation method (DEIM), Proper orthogonal decomposition (POD), Swing equation

Paper type Research paper

1. Introduction

Simulation of nonlinear dynamics of large power grid networks have heavy computational cost and time implications. An example of such modeling and simulation methods are the energy based methods (Magnusson (1947)) which investigate the dynamical behavior of large, nonlinear power system models. However, the size and associated nonlinearity of the power grid network makes the dynamics computationally expensive. The computational requirements can reduce by using model order reduction (MOR) techniques. Application of MOR strategies result in computationally cheaper models which are accurate and retain the original dynamics of the full order model (FOM). In literature, several MOR schemes are available, although the selection of a particular scheme depends upon the type of problem to be solved (Harutyunyan *et al.*, 2015). Some popular approaches are: balanced truncation, moment matching, proper orthogonal decomposition (POD) (Harutyunyan *et al.*, 2015), missing point estimation (Astrid *et al.*, 2008) and proper generalized decomposition (Chinesta *et al.*, 2011).

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