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Original article

Proper Generalized Decomposition based dynamic data driven inverse identification[☆]

D. González[a], F. Masson[a,b], F. Poulhaon[b], A. Leygue[b], E. Cueto[a,*], F. Chinesta[b]

[a] *Aragón Institute of Engineering Research (I3A), Universidad de Zaragoza, Spain*
[b] *GeM UMR CNRS-ECN, École Centrale de Nantes, France*

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Abstract

Dynamic Data-Driven Application Systems—DDDAS—appear as a new paradigm in the field of applied sciences and engineering, and in particular in Simulation-based Engineering Sciences. By DDDAS we mean a set of techniques that allow the linkage of simulation tools with measurement devices for real-time control of systems and processes. One essential feature of DDDAS is the ability to dynamically incorporate additional data into an executing application, and in reverse, the ability of an application to dynamically control the measurement process. DDDAS need accurate and fast simulation tools using if possible off-line computations to limit as much as possible the on-line computations. With this aim, efficient solvers can be constructed by introducing all the sources of variability as extra-coordinates in order to solve the model off-line only once. This way, its most general solution is obtained and therefore it can be then considered in on-line purposes. So to speak, we introduce a physics-based meta-modeling technique without the need for prior computer experiments. However, such models, that must be solved off-line, are defined in highly multidimensional spaces suffering the so-called curse of dimensionality. We proposed recently a technique, the Proper Generalized Decomposition—PGD—able to circumvent the redoubtable curse of dimensionality. The marriage of DDDAS concepts and tools and PGD off-line computations could open unimaginable possibilities in the field of dynamic data-driven application systems. In this work we explore some possibilities in the context of on-line parameter estimation.

Keywords: Dynamic data-driven application systems; Proper Generalized Decomposition; Nonlinear dynamical systems; Inverse identification; Model reduction

1. Introduction

1.1. Dynamic data-driven application systems—DDDAS

Traditionally, Simulation-based Engineering Sciences—SBES—relied on the use of static data inputs to perform the simulations. These data could be parameters of the model(s) or boundary conditions, outputs at different time instants,

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* Corresponding author.
E-mail addresses: gonzal@unizar.es (D. González), francoise.retat@ec-nantes.fr (F. Masson), Fabien.Poulhaon@eleves.ec-nantes.fr (F. Poulhaon), Adrien.Leygue@ec-nantes.fr (A. Leygue), ecueto@unizar.es (E. Cueto), Francisco.Chinesta@ec-nantes.fr (F. Chinesta).

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