Accepted Manuscript

Asynchronous space-time domain decomposition method with localized uncertainty quantification

Waad Subber, Karel Matouš

PII: S0045-7825(16)31910-7
DOI: http://dx.doi.org/10.1016/j.cma.2017.07.011
Reference: CMA 11513

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date : 26 December 2016
Revised date : 20 June 2017
Accepted date : 11 July 2017

Please cite this article as: W. Subber, K. Matouš, Asynchronous space-time domain decomposition method with localized uncertainty quantification, *Comput. Methods Appl. Mech. Engrg.* (2017), http://dx.doi.org/10.1016/j.cma.2017.07.011

Asynchronous Space-Time Domain Decomposition Method with Localized Uncertainty Quantification

Waad Subber[a], Karel Matouš[a,b,*]

[a]*Center for Shock Wave-processing of Advanced Reactive Materials (C-SWARM)*
[b]*Department of Aerospace and Mechanical Engineering*
University of Notre Dame
Notre Dame, IN 46556

Abstract

The computational cost associated with uncertainty quantification of engineering problems featuring localized phenomenon can be reduced by confining the random variability of the model parameters within a region of interest. In this case, a localized treatment of mesh and time resolutions is required to capture the effect of the confined material uncertainty on the global response. We present a computational approach for localized uncertainty quantification with the capability of asynchronous treatment of mesh and time resolutions. In particular, we allow each subdomain to have its local uncertainty representation and the corresponding mesh and time resolutions. As a result, computing resources can be directed toward a small region of interest where a model with high spatial and temporal resolutions is required. To verify the numerical implementation, we consider elastic wave propagation in an axially loaded beam. Moreover, we perform convergence studies with respect to the spatial and temporal discretizations as well as the size of an uncertain subdomain. A projectile impacting a composite sandwich plate is considered as an engineering application for the proposed method.

Keywords: Uncertainty Quantification, Domain Decomposition Method, Asynchronous Time Integration, Non-matching Grids, Impact Dynamics.

1. Introduction

Many practical engineering applications rely on the predictive capability of computer simulations [1]. Advances in computing power and numerical algorithms facilitate such predictions of large-scale applications using parallel computing (e.g., [2]). However, for the credibility of the computer predictions, it is critical to quantity uncertainty in the numerical simulations due to the random variability of the model parameters [3, 4, 5, 6]. Uncertainty Quantification

*Corresponding author
Email addresses: `wsubber@nd.edu` (Waad Subber), `kmatous@nd.edu` (Karel Matouš)