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S.E. Pryse, S. Adhikari, A. Kundu

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Sample-based and sample-aggregated based Galerkin projection schemes for structural dynamics

S E Pryse[a,*], S Adhikari[a], A Kundu[b]

[a] *Zienkiewicz Centre for Computational Engineering, College of Engineering, Swansea University, Swansea SA1 8EN, UK*

[b] *Applied and Computational Mechanics, Cardiff School of Engineering, Queen's building, The Parade, Cardiff CF24 3AA, UK*

Abstract

A comparative study of two new Galerkin projection schemes to compute the response of discretized stochastic partial differential equations is presented for discretized structures subjected to static and dynamic loads. By applying an eigen-decomposition of a discretized system, the response of a discretized system can be expressed with a reduced basis of eigen-components. Computational reduction is subsequently achieved by approximating the random eigensolutions, and by only including dominant terms. Two novel error minimisation techniques have been proposed in order to lower the error introduced by the approximations and the truncations: a) Sample-based Galerkin projection scheme, b) Sample-aggregated based Galerkin projection scheme. These have been applied through introducing unknown multiplicative scalars into the expressions of the response. The proposed methods are applied to analyse the bending of a cantilever beam with stochastic parameters undergoing both a static and a dynamic load. For the static case the response is real, however the response for the case of a dynamic loading is complex and frequency-dependent. The results obtained through the proposed approaches are compared with those obtained by utilising a direct Monte Carlo approach.

Keywords: Stochastic differential equations; eigenfunctions; Galerkin; projection; reduced methods.

1. Introduction

The mathematical models and the parameters used to model physical systems are idealizations of physical processes. They cannot often be known for certain, and a degree of randomness is involved. In fact, input uncertainty in the form of material parameters, geometrical configuration or boundary conditions are ubiquitous and intrinsic to the models being analysed. Many civil engineering problems are concerned with materials that are

*Corresponding author. Tel: +44 (0)1792 602088, Fax: + 44 (0)1792 295676
Email address: 656060@swansea.ac.uk (S E Pryse)