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Projection methods for stochastic dynamic systems: a frequency domain approach

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Abstract

A collection of hybrid projection approaches are proposed for approximating the response of stochastic partial differential equations which describe structural dynamic systems. In this study, an optimal basis for the approximation of the response of a stochastically parametrized structural dynamic system has been computed from its generalized eigenmodes. By applying appropriate approximations in conjunction with a reduced set of modal basis functions, a collection of hybrid projection methods are obtained. These methods have been further improved by the implementation of a sample based Galerkin error minimization approach. In total six methods are presented and compared for numerical accuracy and computational efficiency. Expressions for the lower order statistical moments of the hybrid projection methods have been derived and discussed. The proposed methods have been implemented to solve two numerical examples: the bending of a Euler-Bernoulli cantilever beam and the bending of a Kirchhoff-Love plate where both structures have stochastic elastic parameters. The response and accuracy of the proposed methods are subsequently discussed and compared with the benchmark solution obtained using an expensive Monte Carlo method.

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

1. Introduction

The analysis of complex stochastically parametrized engineering structures has recently received significant interest. One of the main factors affecting the analysis is the computational cost associated with computing the response of a system. This can be mainly attributed to the dimension of the structure under consideration. In order address

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