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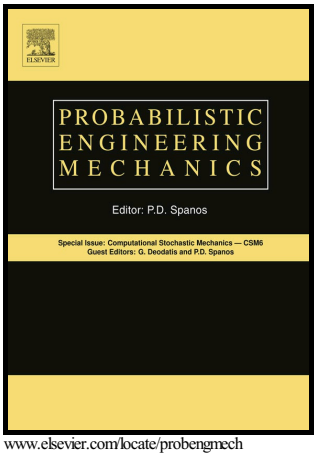

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PII: S0266-8920(16)30019-4
DOI: http://dx.doi.org/10.1016/j.probengmech.2016.11.001
Reference: PREM2918

To appear in: *Probabilistic Engineering Mechanics*

Received date: 24 March 2016
Revised date: 4 October 2016
Accepted date: 21 November 2016

Cite this article as: Michael D. Shields and Hwanpyo Kim, Simulation of higher order stochastic processes by spectral representation, *Probabilistic Engineering Mechanics,* http://dx.doi.org/10.1016/j.probengmech.2016.11.001

Simulation of higher-order stochastic processes by spectral representation

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Abstract

The Spectral Representation Method is generalized for simulation of asymmetrically nonlinear (skewed higher-order) stochastic processes. This is achieved by deriving new orthogonal increments for the spectral process in the Cramér spectral representation that include wave interactions and satisfy third-order orthogonality properties. These orthogonal increments are derived by introducing two new quantities - the pure power spectrum and the partial bicoherence - that decouple the contributions of single waves and wave interactions in the Fourier-type expansion of a stochastic process. The further extension to fourth and higher-order processes is discussed. Several mathematical examples demonstrate the capabilities of the proposed methodology to generate general third-order stochastic processes. The method is then applied to the generation of turbulent wind velocities characterized from Large Eddy Simulations of the atmospheric boundary layer.

Keywords: Non-Gaussian stochastic process, Nonlinear stochastic process, Bispectrum, Stochastic expansion, Simulation

1. Introduction

Stochastic process theory has wide-ranging applications in engineering mechanics from characterizing and synthesizing heterogeneous materials to the dynamics of ocean waves, wind loads, and earthquake accelerations. Computational analysis of these stochastic sys-

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