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ENHANCED HYBRID SIMULATION OF NON-HOMOGENEOUS NON-GAUSSIAN STOCHASTIC FIELDS

*** George Stefanou[1], Vissarion Papadopoulos[2] and Nikos D. Lagaros[3]**

[1] National Technical University of Athens
Athens, GR-15780, Greece
stegesa@central.ntua.gr
http://users.ntua.gr/stegesa

[2] National Technical University of Athens
Athens, GR-15780, Greece
vpapado@central.ntua.gr

[3] National Technical University of Athens
Athens, GR-15780, Greece
nlagaros@central.ntua.gr
http://users.ntua.gr/nlagaros

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ABSTRACT

The problem of simulating non-Gaussian stochastic processes and fields has recently received considerable attention in the field of stochastic mechanics. However, most of the existing work on non-Gaussian processes and fields has been devoted to the stationary/homogeneous case. Limited work is available for samples with temporally or spatially varying marginal probability density function (PDF) and/or spectral density function (SDF) [1]. This kind of stochastic processes and fields is very useful e.g. for the simulation of the material properties and microstructure of functionally graded composites or the accurate representation of initial geometric imperfections in shell buckling studies [1,2].

Recently, a novel enhanced hybrid method has been proposed for the simulation of homogeneous non-Gaussian stochastic fields with prescribed target marginal distribution and SDF [3]. This approach is based on the translation field concept [4], but uses an extended empirical non-Gaussian to non-Gaussian mapping for the generation of a non-Gaussian field having the prescribed characteristics. In this way, the possible incompatibility between the marginal distribution and the correlation structure of a translation field is surpassed and an algorithm covering a wider range of non-Gaussian fields is produced. The function fitting ability of Neural Networks (NN) is employed to approximate the power spectrum of the underlying Gaussian field and the target non-Gaussian distribution and SDF are matched with remarkable accuracy even in the case of narrow-banded fields with very large skewness.

In this work, the enhanced hybrid method is extended to the non-homogeneous case i.e. the simulation of non-homogeneous non-Gaussian stochastic fields with prescribed marginal distribution and spatially varying SDF. The updated algorithm makes use of the spectral representation method coupled with evolutionary spectra theory in order to generate sample functions of the underlying Gaussian stochastic field. The computational efficiency and various features of the new algorithm are demonstrated with the simulation of two stochastic fields having different correlation structure and following a highly skewed non-Gaussian distribution.

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