11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

STATISTICAL RECONSTRUCTION OF MULTIPHASE RANDOM MEDIA

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Key Words: *Heterogeneous Media, Composite Material, Stochastic Finite Element Methods, Stochastic Modelling, Uncertainty, Probabilistic Engineering.*

Multi-phase random media such as rocks, concrete, alloy and composite materials are ubiquitous in the natural environment and engineering. Their mechanical, thermal and electrical etc. properties exhibit a strong random nature with discontinuities on the interfaces between different phases. The responses of multi-phase random media subjected to force, thermal or other type of loading are often of great interest to engineers and researchers, and such responses should be analyzed in the sense of statistics due to the inherent heterogeneity. At present, Monte Carlo methods remain the most popular and versatile approach for simulating the randomness of multi-phase random media and estimating their stochastic responses. The effectiveness of Monte Carlo methods relies largely on rapid reconstruction of large amounts of samples that can accurately represent the diversity and variation of the practical random media under simulation.

The main focus of this work is on the reconstruction of multiphase heterogeneous materials with random morphology, based on statistical characteristics derived from a few measured samples. A highly efficient method has been developed for reconstructing multiphase composite materials with random morphology. It can be used for Monte Carlo simulations which require rapid reconstruction of large amounts of samples according to statistical characteristics derived from a few measured samples (reference samples). The new method is based on nonlinear transformation of Gaussian random fields. The explicitly reconstructed media are able to meet the discrete-valued marginal probability distribution function and the two point correlation function of the reference media. The new method has the following advantages:

- It is thousands of times faster than the simulated annealing method, which is considered as the benchmark method for random media reconstruction. Unlike the simulated annealing method, where the simulation parameters need to be determined empirically (e.g. shape and size for pixel block exchange, annealing temperature and median filter et.), the proposed method is easy to implement and requires only the reference media sample as the input.
- Though the joint probability function of all points is needed to uniquely determine a random field, the marginal distribution plus covariance can offer considerable

information for the morphology of practical random media. The proposed method shows sound reconstruction results for various types of 2D and 3D random media, as demonstrated by the examples.

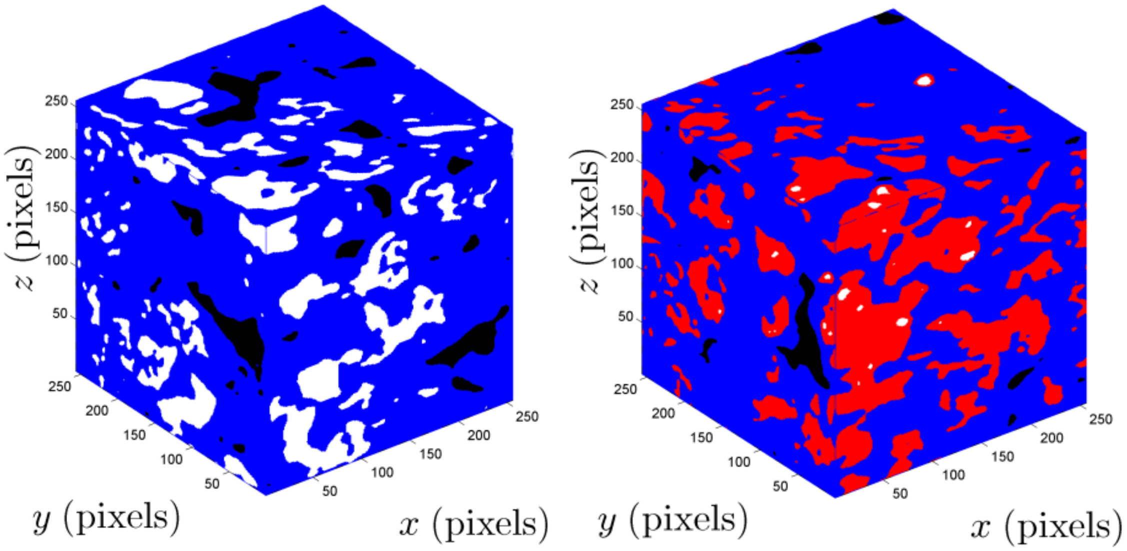

Figure 1. Example of random media reconstruction

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