

A GALERKIN METHOD WITH TWO-DIMENSIONAL HAAR BASIS FUNCTIONS FOR THE COMPUTATION OF THE KARHUNEN-LOÈVE EXPANSION

JUAREZ S. AZEVEDO¹, SAULO P. OLIVEIRA² AND FELIPE WISNIEWSKI²

¹CETEC-UFRB, Centro, 44380-000, Cruz das Almas-BA, Brazil
juarezsa@gmail.com

²DMAT-UFPR and INCT-GP, 81531-980, Curitiba-PR, Brazil
saulopo@ufpr.br

ABSTRACT

We study the numerical approximation of a homogeneous Fredholm integral equation of second kind associated with the Karhunen-Loève expansion of Gaussian random fields. We employ the Galerkin method with two-dimensional Haar wavelets as basis functions. The shape functions are constructed from the orthogonal decomposition of tensor product spaces of one-dimensional Haar functions, and a recursive algorithm is employed to compute the matrix of the discrete eigenvalue system without the explicit calculation of integrals. Numerical experiments confirm the convergence rate of the method and assess the approximation error and the sparsity of the eigenvalue system when the wavelet expansion is truncated. We also illustrate the numerical solution of a diffusion problem with random input data with the present method.

REFERENCES

- [1] J. S. Azevedo, M. A. Murad, M. R. Borges, and S. P. Oliveira. A space–time multiscale method for computing statistical moments in strongly heterogeneous poroelastic media of evolving scales. *Int. J. Numer. Meth. Engrg.* (2012) 90(6):671–706.
- [2] E. Babolian, S. Bazm, and P. Lima. Numerical solution of nonlinear two-dimensional integral equations using rationalized Haar functions. *Commun. Nonlinear Sci. Numer. Simulat.* (2011) 16(3):1164–1175.
- [3] H-A. Derili, S. Sohrabi, and A. Arzhang. Two-dimensional wavelets for numerical solution of integral equations. *Math. Sci.* (2012) 6:4.
- [4] S. G. Mallat. A theory for multiresolution signal decomposition: The wavelet representation. *IEEE Trans. Pattern Anal. Mach. Intell.*, 11(7):674–693, (1989).
- [5] K. K. Phoon, S. P. Huang, and S. T. Quek. Implementation of Karhunen-Loève expansion for simulation using a wavelet-Galerkin scheme. *Prob. Eng. Mech.* (2002) 17(3):293–303.