COMPUTATIONAL UNCERTAINTY QUANTIFICATION FOR ELECTROMAGNETIC WAVE SCATTERING BY RANDOM SURFACES

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Abstract. We present an analysis for the numerical approximation of solutions for the time-harmonic, electromagnetic lossy cavity problem on domains with uncertain geometry. Assuming a high-dimensional parametrization of the stochastic geometry, the problem may be equivalently stated on a fixed nominal domain as a Maxwell-cavity problem with inhomogeneous coefficients with possible low regularity; but with holomorphic parametric dependence in the differential operator. We provide a fully discrete computational scheme for the forward problem, composed of a sparse-grid interpolation in the high-dimensional parameter domain characterizing the scatterers' shape and an $\mathbf{H}(\mathbf{curl})$-conforming edge element discretization of the parametric problem in the nominal domain. As a stepping-stone for our results, we derive a Strang-type lemma for the Maxwell problem and which is of interest by itself. The numerical analysis of the scheme accommodates Sobolev regularity up to $s \geq 1/2$, and computational experiments confirm our theoretical results.

Keywords: Uncertainty Quantification, Shape Holomorphy, High-dimensional Quadratures, Error analysis.
Mathematics Subject Classifications (2010): 35B30, 32D05, 35Q61, 65N12

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