STRUCTURAL SHAPE OPTIMIZATION UNDER LOADING AND MATERIAL UNCERTAINTY VIA THE LEVEL SET METHOD

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Abstract. A stochastic shape optimization method for continuous structures under uncertain loading and material using the level-set method is proposed. Addressing the stochastic linear elasticity problem in its weak form, explicit expressions for the continuous shape derivatives are obtained. An adaptive anisotropic sparse grid is used to solve the stochastic linear system of elasticity and its associated adjoint system.

1. Introduction

This work presents a stochastic framework to address the robust shape structural optimization problem in the continuous weak form of the linear system of elasticity with random input data. Such a framework is therefore not limited by the discretization method. The uncertainty of input data is modeled by using random variables and random fields. The chosen robustness criterion is a weighted sum of the expectation and variance of the structure's compliance. The proper stochastic problem formulation is ensured by the proof of an existence result on a certain class of admissible shapes. Precisely, bounded domains which satisfy the classical ε-cone property and a typical volume constraint. The numerical resolution of the problem process makes use of the analytic expressions for the continuous shape derivatives, which require the resolution of the stochastic linear system of elasticity and its adjoint system. These systems are solved numerically using an anisotropic sparse grid stochastic collocation finite element method. The effectiveness of the proposed approach is verified using benchmarks subjected to loading and material uncertainties, including Gaussian and Non-Gaussian uncertainties, as well as random variables and smooth random fields. As an illustration, next figure shows results for the electric mast problem with horizontal loading uncertainty which is modelled as independent random variables following a uniform distribution on $(0, 1)$. See [1] for details.

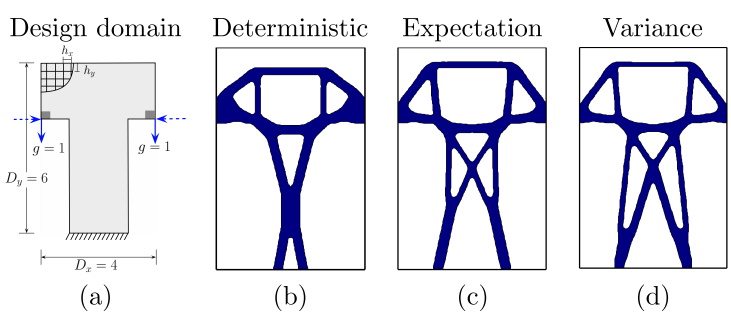

Figure 1. (a) Configuration problem, (b) optimized deterministic design, and robust optimized designs for minimal expectation (c) and minimal expectation and variance (d).

References

[1] J. Martínez-Frutos, D. Herrero, M. Kessler, F. Periago, *Robust shape optimization of continuous structures via the level set method*, in revision in Comput. Meth. Appl. Mech. Eng.