An efficient approach for reliability-based optimization of linear dynamical structures subject to Gaussian excitation

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Abstract

One common task in structural engineering is to devise optimal structures according to a given criterion, while satisfying certain performance requirements. Proper design procedures must take into account all related uncertainties, since they may cause significant changes in the performance and reliability of final designs; see Schuëller and Jensen (2008). This work proposes an efficient approach for reliability-based optimization of linear dynamical structures subject to stochastic Gaussian excitation. Constraints over the system performance are expressed in terms of first excursion probabilities, which quantify the plausibility of one or more responses exceeding prescribed thresholds during a certain time period. First excursion probabilities are evaluated using Directional Importance Sampling (DIS), an advanced simulation method that also provides an estimate of the reliability sensitivities as a by-product; see Misraji et al. (2020). This technique is coupled with an efficient feasible direction interior point algorithm, in which every iteration provides a better design that satisfies the reliability constraints; see Jensen, Becerra and Valdebenito (2013). The capabilities of the proposed approach are illustrated by means of an application example.

References

Schuëller, G. I. and H. A. Jensen. Computational methods in optimization considering uncertainties - An overview. *Comput Method Appl M*, 198:2–13, 2008.

Misraji, M. A., M. A. Valdebenito, H. A. Jensen and F. Mayorga. Application of directional importance sampling for estimation of first excursion probabilities of linear structural systems subject to stochastic Gaussian loading. *Mech Syst Signal Pr*, 139:106621, 2020.

Jensen H. A., L. G. Becerra and M. A. Valdebenito. On the use of a class of interior point algorithms in stochastic structural optimization. *Comput Struct*, 126:69–85, 2013.