Robust dynamic topology optimization under hybrid uncertainties using a level set method

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Abstract

Dynamic topology optimization is of great importance in structural engineering and has been widely studied in a variety of problems. This paper will develop a new robust topology optimization method for dynamic problems subject to hybrid uncertainties. An improved Polynomial Chaos-Chebyshev Interval (iPCCI) method based on the Sparse Grid Numerical Integration (SGNI) is proposed for uncertainty analysis of the robust design. In the original PCCI orthogonal polynomial model, the coefficients of the polynomials are often calculated by using multi-dimensional quadrature methods. However, the number of integration points for the quadrature will grow rapidly with the increase of the number of input variables, which makes the original PCCI less efficient. In this paper, the SGNI that provides an alternative but more efficient approach in obtaining the original tensor-product multi-dimensional quadrature is introduced into the PCCI to solve the coefficients of the polynomials. After the iPCCI uncertain analysis, an effective parametric level set method is applied to find the solution for the robust topology optimization problem. Several numerical examples are used to demonstrate the effectiveness of the proposed robust topology optimization method.

Keywords: Robust topology optimization; Hybrid uncertainties; Polynomial Chaos-Chebyshev Interval method; Sparse Grid Numerical Integration.