Static structural uncertainty analysis based on a modified double Monte Carlo method

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Engineering design and analysis inherently are made under uncertainty. The characterization of this uncertainty is an essential step in the design and analysis. Traditional uncertainty analysis generally uses probability approach to quantify the uncertainty, while it needs a great amount of information to construct precise distributions of the uncertainty parameters. In this paper, parameterized probability boxes (p-boxes) are used to express the uncertainty parameters. A parameterized p-box is the set of all possible distributions which distributions of random variables are known and some of their distributions are not given precise values but variation intervals. Due to the existence of the interval parameters, uncertainty analysis method of parameterized p-boxes involve in double loop calculation. Double Monte Carlo Sampling is one of the typical algorithms. The method might become too computationally expensive for high-dimension problems. To overcome this problem, a new method is proposed. A monotonicity analysis is carried out for uncertainty propagation of the random variables, through which effects of the interval distributions parameters on the output probability bounds. Based on the monotonicity analysis, the outer parameters loop is direct replaced and computational cost is decrease due to the decreased number of function evaluations. Three numerical examples are presented to demonstrate the effectiveness of the present method.

Keywords: parameterized probability boxes, uncertainty analysis, static structural analysis, Double Monte Carlo, Epistemic uncertainty