A marginal interval analysis method based on evidence theory for structural uncertainty propagation analysis

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Abstract:

Due to environment conditions, model errors and incomplete information, etc., uncertainty widely exist in practical engineering problem. Due to the flexibility of evidence framework, evidence theory is recognized as a more general analysis model for epistemic uncertainty under limited information. In traditional propagation analysis based on evidence theory, extremum analysis is required in each focal element. Hence, the computational cost of evidence propagation is very huge, especially for the high dimensional problem. In order to improve the propagation efficiency of evidence theory, an efficient marginal interval analysis method is proposed by combining dimension reduction decomposition technique in this paper. This method can decompose the multidimensional extremum searches for all joint focal elements into the combination of finite one-dimensional extremum searches, and the one-dimensional extremum search can be efficiently realized by collocating a few marginal nodes. Hence, the proposed method can significantly improve the computational efficiency of propagation analysis based on evidence theory, especially for the high dimensional uncertainty problems. Meanwhile, because the actual structural response at each marginal collocation node is used, the proposed marginal interval analysis method can provide relatively accurate propagation results under the requirement of efficiency.

Keywords: Evidence theory; Epistemic uncertainty, propagation analysis, Dimension reduction decomposition, Marginal collocation nodes