

PROCEEDINGS

Uncertainty Quantification of Complex Engineering Structures Using PCE-HDMR

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ABSTRACT

The "curse of dimensionality" faced by high-dimensional complex engineering problems can be tackled by a set of quantitative model evaluation and analysis tools named high-dimensional model representation (HDMR) [1,2], which has attracted much attention from researchers in various fields, such as global sensitivity analysis (GSA) [3], structural reliability analysis (SRA) [4], CFD uncertainty quantification [5] and so on [6]. In this paper, a new method for uncertainty quantification is proposed. Firstly, PCE-HDMR for SRA is developed by taking advantage of the accuracy and efficiency of PCE-HDMR for modeling high-dimensional problems [7]. Secondly, the formulas for the statistical moments and global sensitivity indices are theoretically derived by utilizing the orthogonality of the PCE-HDMR component functions. Finally, the effectiveness and accuracy of the proposed method are verified by one benchmark function (i.e., Ishigami function) and two engineering examples (i.e., a planar truss structure and a full-size offshore jacket platform). The results show that PCE-HDMR is closer to the results of the Monte Carlo method than PCE in calculating the global sensitivity indices, reliability index and failure probability. In conclusion, the GSA and SRA method based on PCE-HDMR proposed in this paper can be accurately and efficiently applied to uncertainty quantification of large and complex engineering structures.

KEYWORDS

Uncertainty quantification; PCE-HDMR; global sensitivity analysis; structural reliability analysis

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