Reliability-Based Design Optimization Using A Maximum Confidence Enhancement Based Sequential Sampling Approach

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Abstract

This paper presents a maximum confidence enhancement based sequential sampling approach for simulation-based design under uncertainty. In the proposed approach, the ordinary Kriging method is adopted to construct surrogate models for all constraints and thus Monte Carlo simulation is able to be used to estimate reliability and its sensitivity with respect to design variables. A cumulative confidence level is defined to quantify the accuracy of reliability estimation using MCS based on the Kriging models. To improve the efficiency of proposed approach, a maximum confidence enhancement based sequential sampling scheme is developed to update the Kriging models based on the maximum improvement of the defined cumulative confidence level, in which a sample that produces the biggest improvement of the cumulative confidence level is selected to update the surrogate model. Moreover, a new design sensitivity estimation approach based upon constructed Kriging models is developed to estimate the reliability sensitivity information with respect to design variables without incurring any extra function evaluations. This enables to compute smooth sensitivity values and thus greatly enhances the efficiency and robustness of the design optimization process. Two case studies are used to demonstrate the proposed methodology.

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