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A Novel Methodology of Reliability-based Multidisciplinary Design Optimization under Hybrid Interval and Fuzzy Uncertainties

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Abstract: Various uncertainties exist in engineering practice, which brings adverse effects to the reliability of complicated engineering systems. Considering the case that interval and fuzzy uncertainties exist simultaneously, a new reliability estimation model is proposed based on the level cut strategy and volume ratio theory. The new reliability model is better than the traditional one which is very conservative. Moreover, a sequential optimization and reliability assessment (SORA) approach for multidisciplinary systems under hybrid interval and fuzzy uncertainties is developed to decouple the reliability analysis from the deterministic multidisciplinary design optimization (MDO). In the framework of SORA, the deterministic MDO and reliability analysis are executed sequentially, thus the efficiency can be improved. For the multidisciplinary uncertainty analysis, the first order Taylor expansion method and the interval vertex method are formulated. The calculation of the safety possibility under the volume ratio theory and the calculation of the shifting distance are deduced. Both numerical and engineering examples are employed to demonstrate the validity of the proposed method.

Keywords: reliability-based multidisciplinary design optimization; hybrid interval and fuzzy uncertainties; reliability estimation model; sequential optimization and reliability analysis; shifting distance

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