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# Optimization of Structures with Hybrid Uncertainties

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This paper addresses the uncertain optimization which is a collective name of the robust optimization and reliability optimization. There are many uncertain parameters in structures, including both the probabilistic uncertainty and the non-probabilistic uncertainty, so we propose a new uncertain optimization method which can handle the random variables and interval variables simultaneously. The reliability and robust index are considered under the condition of the worst case combination of interval variables. The disadvantage of traditional nested optimization procedure, expensive computational cost, would be worse when the hybrid uncertainties are considered. To improve the computational efficiency, the combination of the Polynomial Chaos (PC) theory [1] and Chebyshev interval inclusion function [2, 3] is used to estimate the interval mean and interval variance of the design functions, replacing the inner optimization loop, where the PC theory is employed to handle the random uncertainty, while the Chebyshev inclusion function is used to settle the interval uncertainty. The reliability and robust index are evaluated based on the interval mean and interval variance, then used in structure optimization directly. Both the PC method and Chebyshev inclusion function belong to non-intrusive methods which only require the value of design function with some special inputs, without taking care of the calculation procedure of the design function. Therefore, the proposed method may be applied in many design functions with complex expression or calculation procedure, even in black-box models. Two structures uncertain optimization examples are provided, which shows the good performance of the proposed method.

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