Constrained Global Design Optimization Using a Multi-fidelity Model

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ABSTRACT

In many engineering optimization problems, the number of function evaluations is severely limited due to time or cost for obtaining the optimal solution when the time for one function evaluation is long. In this study, we present a constrained global optimization method using a multi-fidelity model. A multi-fidelity model is a surrogate that combines two models of different fidelities. The multi-fidelity model has been used to obtain unconstrained optimal solution with less number of function evaluations than using just a high fidelity model. To the authors' knowledge, this is the first attempt to solve the constrained optimization problem using a multi-fidelity model.

The multi-fidelity model we used in this study is that based on Bayesian prediction. For sequential sampling taking the constrained global optimization into account, we formulate an optimization problem to find an infill sampling point that maximizes the generalized expected improvement while satisfying constraint functions. The generalized expected improvement, a generalized form of the expected improvement, balances a local exploitation and a global exploration with a cooling scheme. To solve the formulated optimization problem, we employ the pattern search method to find the constrained global optimal solution. The sequential sampling terminates when stopping criteria are met.

In order to demonstrate the effectiveness and usefulness of the proposed method, several mathematical problems are solved and its performance is compared to that of constrained global optimization methods using a high fidelity model only.

Key words: constrained global optimization; multi-fidelity model; generalized expected improvement

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