Machine learning-based closed loop parameter optimization for MMC-based topology optimization

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Abstract

The developed topology optimization for mobile components, e.g. Moving Morphable Component (MMC), have been not only used to mini-compliance optimization problems, but also applied to stress constraints, geometric constraints and so on. Nevertheless, the optimization process of the MMC strongly depends on the selection of convex approximation parameters for the Method of Moving Asymptote (MMA), which results in that this algorithm relies too much on experienced parameters. Furthermore, parameter adjustment takes a lot of time due to the useless of many results. At the same time, the finally obtained results might be only a local optimum. Therefore, as shown in Figure 1, a Machine Learning (ML)-based closed loop parameter optimization method is proposed in this study. The random forest is used to judge whether the optimal structure by the MMC is useful, while Particle Swarm Optimization (PSO) method is employed to find the global optimal structure from the useful structures. As shown in Figure 2, when the population is 20, after 100 iterations, the optimal compliance by the PSO is 52.6626. The corresponding structure image and design variables are shown in Fig. 2 and Table 1, respectively. Moreover, considering the time for an optimization process based on MMC is a litter long, conditional Generative Adversarial Network (cGAN) is applied to construct a surrogate model for the MMC-based topology optimization to accelerate optimization. The cGAN is used to construct the predictor from the structure of 20^{th} iteration to the optimal structure.

Keywords: Machine learning; MMC; PSO; Closed loop; Global optimal.

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Table 1. Identified results

volfrac	asyinit-mma	asyincr-mma	asydecr-mma	albefa-mma
0.5999	0.0619	1.1030	0.6046	0.3048

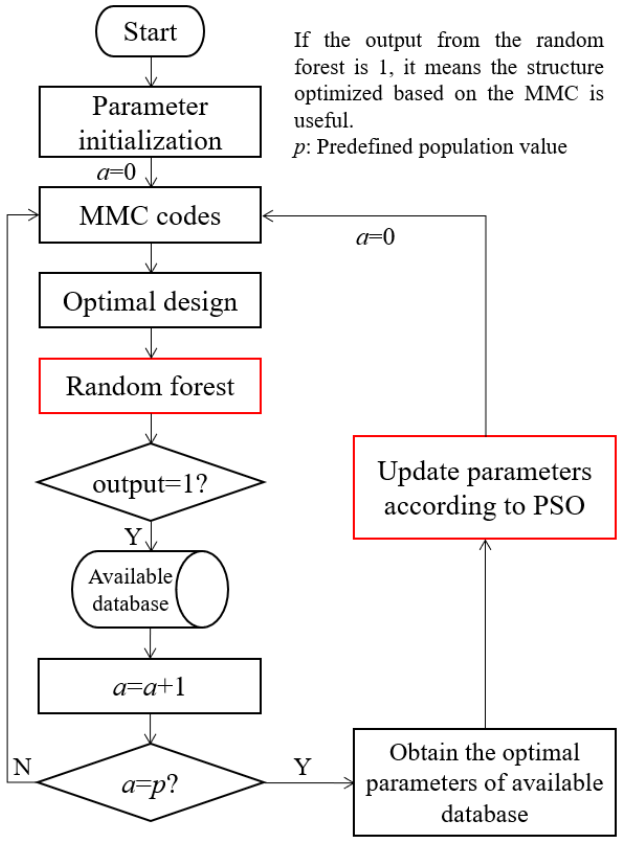

Figure 1. The architecture of the ML-based closed loop parameter optimization for the MMC.

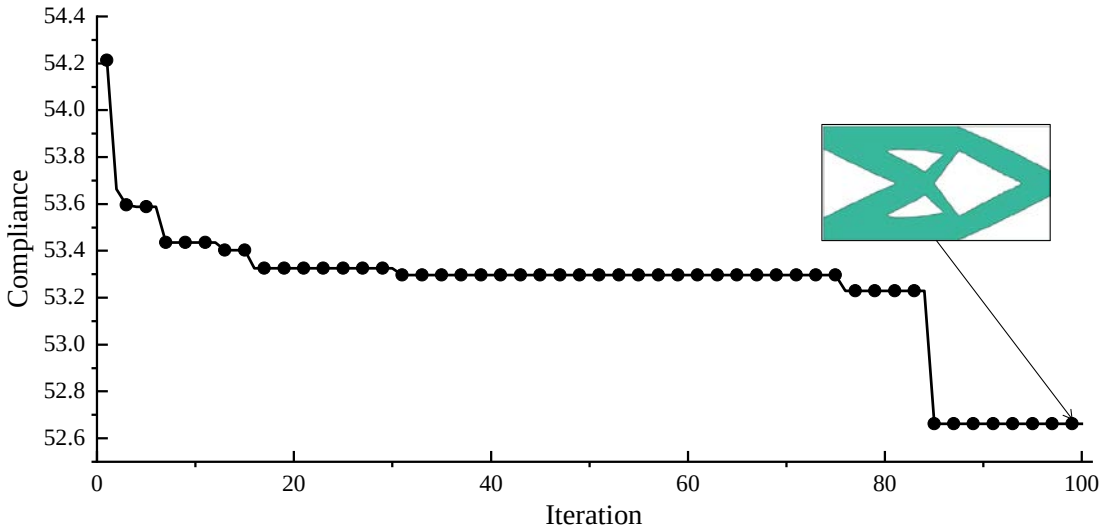

Figure 2. The optimization process by the PSO.