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战术导弹多目标多学科设计优化

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Multiobjective Multidisciplinary Design Optimization of Missile

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摘要

为了对导弹进行多学科设计优化（MDO），建立了包含气动、推进、质量、控制和弹道的多学科分析模型，并采用协作优化对战术导弹多目标多学科设计优化问题进行了表述。针对多目标多学科优化设计问题的计算复杂性，提出了一种新的处理约束多目标优化问题的基于Kriging多目标遗传算法（MOKGA）。MOKGA 采用物理规划法将多目标优化转化为单目标优化，然后构建目标函数的考虑约束的 EI（Expected Improvement） 模型，并采用遗传算法进行求解。将 MOKGA 与多目标优化算法 NSGA-Ⅱ进行了比较。结果表明，NSGA-Ⅱ 和 MOKGA 两种算法的优化结果均较初始方案得到明显改进，但 MOKGA 的精确分析次数较 NSGA-Ⅱ减少了40%，降低了多学科设计优化问题求解过程中的计算复杂性。

关键词： 导弹 多学科设计优化 多目标 遗传算法 物理规划

Abstract:

In order to design missiles with multidisciplinary design optimization (MDO), multidisciplinary analysis models are established which involve such diverse fields as aerodynamics, propulsion, mass, control and trajectory. Collaborative optimization is adopted to formulate the MDO of a missile. Due to the computational complexity of the MDO problem, a new method dealing with constrained multiobjective optimization is proposed, which is multiobjective Kriging based genetic algorithm (MOKGA). Physical programming is used in the method to convert the multiobjective to a single objective, and then EI (Expected Improvement) is made for the single objective taking into consideration the various constraints. Genetic algorithm is used to optimize the EI. Comparison between the multiobjective genetic algorithm NSGA-Ⅱ and MOKGA is made. The results show that the optimized results of both methods are improved as compared with the initial design, but that MOKGA reduces by 40% the number of exact analyses as compared with NSGA-Ⅱ, which reduces remarkably the computational complexity of multidisciplinary design optimization.

Keywords: missile multidisciplinary design optimization multiobjective genetic algorithm physical programming

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