北京航空航天大学学报 » 2011, **Vol. 37** » Issue (11) :1465-1470 **DOI**:

基于径向基函数响应面的机翼有限元模型修正

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Finite element model updating of airplane wing based on Gaussian radial basis function response surface

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摘要 用ANSYS三维实体单元SOLID45建立机翼基准有限元模型并计算其自由振动的前6阶模态频率.用均匀设计方法将结构参数分组并分别计算各组结构参数对应的模态频率,建立高斯径向基函数响应面模型.用最小二乘法则拟合系数并检验响应面拟合精度,对基准模型的结构参数施加摄动量建立待修正有限元模型.用响应面模型和基准模型计算所得模态频率的相对误差建立适应度函数的表达式,将混沌搜索机制引入粒子群算法对结构参数的摄动量进行寻优计算,搜索所得优化解代入即得修正后模型,将修正后模型与基准模型在测试频段内段外的模态频率近似度进行比较,证实了修正后模型的有效性.

关键词: 机翼 均匀设计 高斯径向基函数响应面 混沌搜索机制 粒子群算法

Abstract: The benchmark finite element model(FEM) of the airplane wing was constituted using the three-dimensional solid element SOLID45 in ANSYS, and the uniform design method was employed to group the structure parameters to calculate the corresponding modal frequencies of each set of parameters, then the Gaussian radial basis function(RBF) response surface was constituted, the coefficients of which were fitted by the least square method(LSM), and the fitting precision was evaluated. The non-updated FEM was obtained by adding perturbation to the structure parameters of the benchmark FEM, and the fitness function was constituted based on the difference between the modal frequencies of the benchmark FEM and the Gaussian radial basis function(RBF) response surface, which guided the particle swarm optimization(PSO) algorithm with chaos-search mechanism to search for the perturbation of the structure parameters, the optimal solution was substituted into the non-updated FEM and then the updated FEM was obtained, the validity of the updated FEM is approved by comparing the similarity of the modal frequencies of the updated FEM and the benchmark FEM in and out of the test range.

Keywords: airplane wing uniform design Gaussian radial basis function(RBF) response surface chaos-search mechanism particle swarm optimization(PSO) algorithm

Received 2010-07-14;

Fund:

长江学者创新团队发展计划资助项目(IRT0520)

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引用本文:
秦玉灵, 孔宪仁, 罗文波.基于径向基函数响应面的机翼有限元模型修正[J] 北京航空航天大学学报, 2011,V37(11): 1465-1470

Qin Yuling, Kong Xianren, Luo Wenbo.Finite element model updating of airplane wing based on Gaussian radial basis function response surface[J] JOURNAL OF BEIJING UNIVERSITY OF AERONAUTICS AND A, 2011,V37(11): 1465-1470

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