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基于随机抽样与距离判别的GARTEUR模型修正与确认研究

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Stochastic Model Updating and Validation of the GARTEUR Structure Based on Random Sampling and Distance Discrimination

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摘要 参考文献 相关文章

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摘要

提出了一种基于随机抽样技术与距离判别分析的结构有限元随机模型修正（SMU）方法，并将其应用到GARTEUR飞机模型的有限元模型修正过程中。传统的模型修正方法以灵敏度分析及优化分析方法为核心，对有限元模型的输入参数进行修正。而本文的随机模型方法充分考虑了有限元建模过程与试验测量中普遍存在的不确定性，利用Monte Carlo抽样方法进行大量的随机抽样实验，完成不确定性从输入参数向输出特征的传递分析；在参数修正过程中，利用距离判别分析计算试验与仿真两个数据集之间的统计学差异，并通过迭代程序逐步修正输入参数使仿真数据逐步收敛于测量数据；利用径向基函数，在修正过程中引入代理模型，在保证精度的同时大大降低了随机模型修正的计算量。利用MCS.Patran的二次开发语言PCL开发了随机抽样实验的相关程序，并可以自动收集数据用于参数修正的迭代运算。通过普遍认可的三级确认准则对GARTEUR有限元模型可靠性进行了确认分析，结果表明提出的随机模型修正方法具有可行性和工程应用价值。

关键词： 模型修正 模型确认 不确定性 Monte Carlo法 距离判别分析 GARTEUR

Abstract:

A stochastic model updating (SMU) method using distance discrimination analysis and random sampling technique is proposed and subsequently applied to the updating process of the GARTEUR benchmark structure. In contrast to the traditional deterministic model updating procedure in which parameters are calibrated by sensitivity and optimization analysis, the proposed SMU method takes into consideration uncertainties which are general in the modeling as well as test processes. Uncertainty propagation is performed by Monte Carlo sampling method in which a large scale stochastic sampling process is proposed to describe uncertainties from parameters to features. Distance discrimination analysis is presented to quantify the degree of similarity and dissimilarity between analytical and test data. Input parameters are calibrated to the test data through an iterative procedure integrating the above uncertainty propagation and quantification methods. In order to reduce calculation cost, a metamodel is constructed using radial basis function with an acceptable precision. The relative PCL program of MSC.Patran is employed to submit multiple finite element (FE) analyses and to extract information for subsequent analysis. An application is performed on the GARTEUR structure and the updating results are assessed by the widely accepted 3-steps validation criteria. The updating and validation results show the proposed SMU method is valid and effective in engineering application.

Keywords: model updating model validation uncertainty Monte Carlo method distance discrimination analysis GARTEUR

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