Xue, Liang; Wen, Guilin; Wang, Hongxin; Liu, Jie


Summary: Although the structural vibration can be suppressed by adjusting eigenvalues outside the excitation frequency band, it becomes increasingly difficult to suppress vibration as the width of the excitation frequency band increases. Besides, for some high-precision equipment, e.g., space telescope mirror substrate and rocket motor casings, their complex and diverse modals directly affect the performance. Thus, a novel optimization algorithm was proposed, which applies to achieve eigenvector-based modal control and vibration suppression. The eigenvectors were defined as the objective function, and Nelson’s method without truncation error was used to calculate the sensitivity information. Due to the introduction of dynamic equations, the non-linearity of the objective function is prominent. Then, an improved solver that can handle this non-linear topology optimization problem was proposed. The optimization was performed under a multi-material framework, and the extended multi-material interpolation scheme was proposed to readily realize the optimization with three or more materials. In addition, the consistent mass matrix constructed by multi-material interpolation was used to describe the mass matrix without concentrated mass in the dynamic equation. Moreover, the modal assurance criterion was used to track jumping modals. Finally, the modal controllability was achieved through several numerical examples, which verify the effectiveness of the proposed method.

MSC:
74-XX Mechanics of deformable solids
93-XX Systems theory; control

Keywords:
eigenvector derivative; eigenmode optimization; control mode shape; suppress vibration; topology optimization; multi-material

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