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Summary: Generalized eigenvalue problems are standard problems in computational sciences. They may arise in electromagnetic fields from the discretization of the Helmholtz equation by for example, the finite element method (FEM). Geometrical perturbations of the structure under concern lead to a new generalized eigenvalue problems with different system matrices. Geometrical perturbations may arise by manufacturing tolerances, harsh operating conditions or during shape optimization. Directly solving the eigenvalue problem for each perturbation is computationally costly. The perturbed eigenpairs can be approximated using eigenpair derivatives. Two common approaches for the calculation of eigenpair derivatives, namely modal superposition method and direct algebraic methods, are discussed in this paper. Based on the direct algebraic methods an iterative algorithm is developed for efficiently calculating the eigenvalues and eigenvectors of the perturbed geometry from the eigenvalues and eigenvectors of the unperturbed geometry.

MSC:
78M10 Finite element, Galerkin and related methods applied to problems in optics and electromagnetic theory
65F15 Numerical computation of eigenvalues and eigenvectors of matrices

Keywords:
generalized eigenvalue problem; matrix perturbation; modal sensitivity analysis; Slater’s theorem; eigenvalue reanalysis; microwave cavity

Software:
Matlab; ARPACK

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References:


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