Improved Subspace Iteration Method for Structures with Multiple Eigenvalues

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ABSTRACT

An efficient and numerically stable eigensolution method for structures with multiple natural frequencies is presented. The proposed method is developed by improving the well-known subspace iteration method with shift. A major difficulty of the subspace iteration method with shift is that because of singularity problem, a shift close to an eigenvalue cannot be used, resulting in slower convergence. In this paper, the above singularity problem has been solved by introducing side conditions without sacrifice of convergence. The proposed method is always nonsingular even if a shift is on a distinct eigenvalue or multiple ones. This is one of the significant characteristics of the proposed method. The nonsingularity is proved analytically. The convergence of the proposed method is at least equal to that of the subspace iteration method with shift, and the operation counts of the above two methods are almost the same when a large number of eigenpairs are required. To show the effectiveness of the proposed method, the numerical example is considered.

INTRODUCTION

The eigensolution method is very important in a dynamic analysis of structures when the mode superposition method is used. Many eigensolution methods have been developed, and among these methods, the subspace iteration method has hitherto been known to be very efficient, and so has been widely used.

The subspace iteration method was developed by Bathe and Wilson(1972). This method combines the simultaneous inverse iteration method and the Rayleigh-Ritz analysis. The following shortcomings have been identified after extensive use of the method. These include: (1) slow convergence and large computational and storage costs when a relatively large number of eigenpairs are required; and (2) missed eigenvectors caused by a poor choice of starting trial

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