An octree algorithm together with the cell-based smoothed finite element method (CS-FEM) for adaptive stress analysis

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Abstract

For numerical analysis of complex structural components, the time taken for meshing usually dominate the entire pre-processing. Adaptive meshing is thus ideal to improve the analysis efficiency. Adaptation using triangular meshes offers a solution to the above problems to some extent. However, the stress solution of triangular elements is known less accurate than quadrilateral elements. Therefore, use of quadrilateral elements for adaptive analysis can be a valuable alternative. This work develops a new method that combines the octree algorithm with the cell-based smooth finite element method (CS-FEM) for automatic mesh adaptation for complicated geometries. Since the octree algorithm generates a grid with different sizes of quadrilaterals, a number of CS-FEM elements of n-sided polygon are developed accordingly. In the adaptation process, the energy error norm and geometrical feature are all used as the bases for adaptive refinement. In addition, the elements on curved boundaries are cut or merged with the surrounding elements according to the local shape. This effective reduces the artificial stress concentrations on concave corners, and makes the boundary closer to the original shape of the component. It is found that the octree algorithm works very effective with the CS-FEM formulation for proven stable and convergence solutions. The results obtained by S-FEM are found generally more accurate than those obtained by the FEM counterpart, especially in terms of strain energy solution.

***Keywords*:** finite element method (FEM); cell-based smoothed finite element method (CS-FEM); adaptive analysis; octree algorithm

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