A Smoothed Finite Element Method for Stress Analysis Based on Octree-based Polyhedral Meshes

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Abstract

Techniques are now available to generate high-quality polyhedral elements offering a good alternative way for accurate stress analyses for solids. However, polyhedral elements can't be effectively used in standard finite element methods (FEM) [[1]-[2]] without extra complicated treatments, due to the hanging nodes on the element edges. On the contrary, the hanging nodes can be naturally dealt with in the smoothed finite element method (S-FEM) [[2]-[5]]. Thus, this paper utilizes the octree method to automatically and efficiently generate an unstructured polyhedral mesh, using the standard tessellation language (STL) [[6]]. We develop three S-FEM models for octree meshes, including node-based, edge-based and face-based. A detailed comparison study on accuracy and bound properties of the solution has also been carried out, in references to the exact solutions. A subdomain smoothing technique is proposed for the first time to re-cut the smoothing domain (SD), which simplifies the process. The shapes of the subdomains have some common geometries that are much easier to handle. The introduction of subdomains does not affect the results of the calculations, and the properties of the three S-FEMs are still preserved. Several demonstration examples are presented to verify the efficiency of the present S-FEM models.

Keywords: Finite element method; Smoothed finite element method; Polyhedral element; Octree algorithm; Subdomain for smoothing

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