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PERFORMANCE IMPACT OF TETRAHEDRALIZATION ON PARALLEL CONFORMING OCTREE MESH GENERATION

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The development of powerful computational resources and scalable parallel finite element solvers has created unprecedented new opportunities for scientists and engineers to solve a range of complex, physical phenomena at larger scales and at higher resolutions. Here, high resolution means meshes containing billions of elements [1]. However, build such discretizations efficiently is not an easy task. Octree-based mesh generation methods have achieved high levels of scalability (more than 2000 cores) resulting in reasonable-quality elements [2,3,4]. The present work measures the performance impact from tetrahedralization of nonconforming meshes generated by the octree method. A tetrahedralization technique based on templates is implemented in a meshing algorithm which uses a linear octree with 2:1 balancing constraint from immersed geometries. Element quality measures show the quality of resulting tetrahedral meshes. Performance measurements on the parallel generation of conformal meshes with the present method on 4096 cores show that it is possible to generate a mesh for a real life offshore platform with 9 billion of tetrahedra in less than 40s of CPU time, using an octree with 14 levels. The corresponding hexahedral mesh, with 2:1 constraints is generated in practically the same time. We also introduced a more efficient way of octree partitioning to improve octree refinement load balancing. This new partitioning strategy is able to speed-up load-balancing almost three times. The parallel weak scalability analyses shown here demonstrate that the core procedures for conformal tetrahedralization of octree-based meshes behave very efficiently.

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