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Parallel mesh subdivision to approximate curved geometries

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Abstract

A parallel distributed approach to refine a mesh while preserving the curvature of a target geometry is presented. Our approach starts by generating a coarse linear mesh of the computational domain. Second, the former coarse mesh is curved to match the curvature of the target geometry. Then, the curved mesh is partitioned and the subdomain meshes are sent to the slaves. Finally, the curved elements are uniformly subdivided in parallel targeting the geometry approximated by the curved mesh. The result is a distributed finer linear mesh featuring improved geometric accuracy. The key ingredient of our implementation is to approximate the target geometry as a linear mesh equipped with an elemental field corresponding to an element-wise polynomial geometry representation. Thus, the distribution of the curved geometry is equivalent to partitioning the linear mesh and sending the subdomain meshes and the elemental fields to the slaves. The main application of the obtained finer linear mesh is to compute in parallel steady state flow solutions on real topographies. The qualitative results show that for 2D and 3D steady state flow solutions, on real and synthetic topographies, our parallel subdivision approach mitigates the artificial artifacts that might appear with standard straight-sided subdivision methods. We also check the parallel performance of the implementation by performing a weak scalability test in 2D.

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Keywords: Mesh subdivision, Mesh multiplication, Parallel mesh generation, Parallel computing, High-order mesh

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