Shared-Memory Block-Based Fast Marching Method for Hierarchical Meshes

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Abstract

The Fast Marching Method (FMM) is commonly used in expanding front simulations [1], e.g. fluid dynamics, computer graphics, and process simulation in microelectronics to restore the signed-distance field property of the level-set function, also known as re-distancing. To improve the performance of the re-distancing step, parallel algorithms for the FMM as well as support for hierarchical grids have been developed; the latter to locally support higher resolutions of the simulation domain whilst limiting the impact on the overall computational demand. In this work, the Multi-Mesh FMM presented in [2] is extended by the block-based FMM approach [3] to enable improved serial and parallel performance on hierarchical grids. The OpenMP tasks paradigm is used for the underlying coarse-grained parallelization on a per mesh basis. The employed approach allows for an improved load balance as the algorithm employs a high mesh partitioning degree, enabling to balance mesh partitions with varying mesh sizes. Benchmarks and parameter studies are performed on representative geometries with varying complexities. The serial performance is increased by up to 22 percent whereas a parallel speed up ranging from 7.8 to 11 on a 16 core computing platform has been achieved, which is approximately 47 percent faster than the reference Multi-Mesh FMM approach.
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References

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