A Shared-Memory Parallel Multi-Mesh Fast Marching Method for Full and Narrow Band Re-Distancing

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Abstract

A common problem arising in expanding front simulations is to restore the signed-distance field property of a discretized domain (i.e., a mesh), by calculating the minimum distance of mesh points to an interface. This problem is referred to as re-distancing and a widely used method for its solution is the Fast Marching Method (FMM) [1]. In many cases a particular high accuracy in specific regions around the interface is required. There, meshes with a finer resolution are defined in the regions of interest, enabling the problem to be solved locally with a higher accuracy. Additionally, this gives rise to coarse-grained parallelization, as such meshes can be re-distanced in parallel. An efficient parallelization approach, however, has to deal with interface-sharing meshes, load-balancing issues, and must offer reasonable parallel efficiency for narrow band and full band re-distancing. We present a parallel Multi-Mesh FMM to tackle these challenges: Interface-sharing meshes are handled in a similar way as the inter-subdomain communication mechanism presented in [2]. Parallelization is introduced by applying the pool of tasks concept, implemented using OpenMP tasks. Meshes are processed by OpenMP tasks as soon as threads become available, efficiently balancing out the computational load of unequally sized meshes over the entire computation. Our investigations cover parallel performance of full and narrow band re-distancing as well as load-balancing capabilities. The resulting algorithm shows a good parallel efficiency, if the problem consists of significantly more meshes than the available processor cores.

References

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