



GPU-accelerated Surface Reconstruction for Particle-based Fluids

Wei Wu¹, Hongping Li^{1*}, Tianyun Su², Haixing Liu²

1. College of Information Science and Engineering, Ocean University of China, Qingdao 266100, China

2. The First Institute of Oceanography, SOA, Qingdao 266061, China

Email: lh@ouc.edu.cn



Introduction

Animating fluids with particle-based method has attracted great attention in computer graphics. To render discrete particles, implicit surfaces need to be extracted. But this process is often seen as a bottleneck due to the expensive computation and high memory usage especially for constructing a detailed and artifact-free surface.

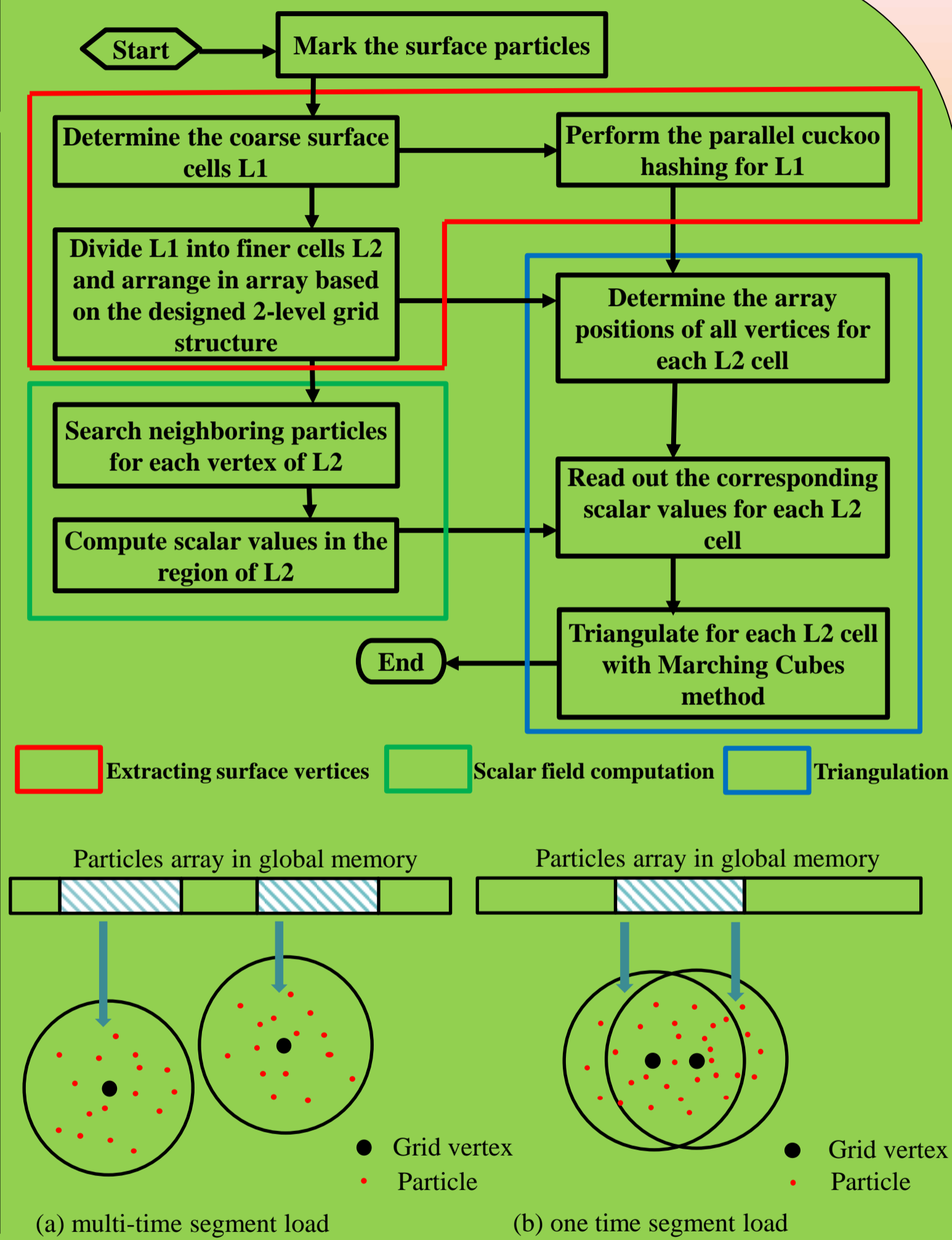
In this work, a GPU accelerated fluids surface reconstruction method using a designed 2-level grid structure is employed with a scheme of arranging fine surface vertices, which could preserve the spatial locality to facilitate the coalesced memory access on GPU. Meanwhile a parallel cuckoo hashing method is taken to help reduce the memory consumption.

A parallel version of the optimized surface reconstruction was performed based on CUDA architecture. In the experiment of comparison to traditional approaches, the results indicated that our surface reconstruction method was more efficient at the same level of quality of the reconstructed surfaces.

Methods

2-level grid structure:

The whole simulation domain is divided with a coarse grid as first level, then the grid cells in the surface region is further divided into finer cells as second level. The fine grid vertices within the same coarse grid cell are continuously stored in global memory, which helps facilitate the coalesced memory access on GPU. Meanwhile, only the coarse vertices in the surface region are hashed to help determine the array position of each fine surface vertex. This makes the memory consumption totally irrelevant with the whole simulation domain.



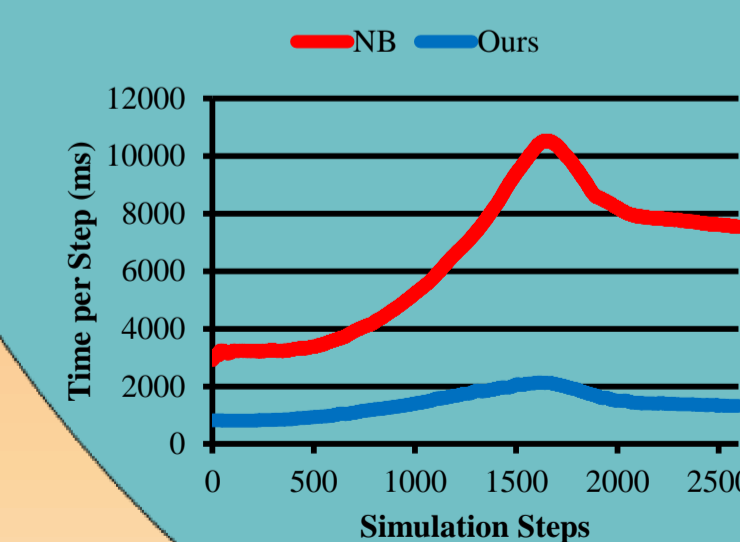
Results and Discussion

A Buddha scene is built where a viscous fluid is poured onto a Buddha statue and collected into a boundary box. PCISPH is employed as the fluid simulation model. CUDA 5.5 is used for GPU parallel computing and OpenGL is used for rendering.



Comparison with the narrow-band method (NB) of Akinci et al.

Method	t_{es} [sec]	t_{sf} [sec]	t_{tri} [sec]	t_{tot} [sec]	MEM[GB]
NB	0.33	5.98	0.09	6.4	3.16
Ours	0.05	1.85	0.14	2.0	0.53



The mainly performance improvement is at the stage of scalar field computation, which is the most time-consuming process. It benefits from the arrangement mode of fine surface vertices that built with the designed 2-level grid structure.

Conclusion

- The performance of running time and memory consumption is largely improved when compared with NB method.
- The quality of the reconstructed surface is the same with NB method.
- The optimized algorithm is designed for high-quality surface generation with high grid resolution, thus the performance improvement is not obvious for a coarse grid.