Multi-Layered Unstructured Mesh Generation

Panagiotis Foteinos 1,2 dfot@cs.wm.edu
Daming Feng 2 dfeng@cs.odu.edu
Andrey Chernikov 2 achernik@cs.odu.edu
Nikos Chrisochoides 2 nikos@cs.odu.edu

1College of William and Mary, Computer Science, Williamsburg, VA, USA
2Old Dominion University, Computer Science, Norfolk, VA, USA

Introduction

- Input: Image
- Output: Mesh
- Faithful representation of the underlying object: Fidelity
- Well shaped tetrahedra: Quality
- Fidelity: symmetric Hausdorff distance, ambient isotopy
- Quality: aspect ratio, radius-edge ratio, size

Goal: scalability on thousands of cores!

Parallel Image-to-Mesh Conversion (PI2M)

Statistics regarding the single-threaded performance and the quality/fidelity achieved by PI2M and CGAL. PI2M includes the extra overhead introduced by synchronization, contention management, and load balancing to support the (potential) presence of other threads.

Bottleneck: memory latency

Considering zero overhead for load balancing and contention, the 106s-14s=92s is far from perfect...

Many small packages increase traffic pressure

Data Decomposition

- Data Decomposition alleviates intensive memory pressure, but it does not eliminate it
- Domain Decomposition separates memory banks
- Delaunay admissible medial axis domain decomposition is difficult in 3D or 4D
- Introduce artificial boundaries that do not hurt fidelity
- 66% efficiency on 48 cores

Domain Decomposition + Data Locality + PI2M: $10^2 \times 6.9 \times (0.66 \times 48) \approx 22,000$ concurrency in an enclosure of 48 racks

Acknowledgements

This work is supported in part by NSF grants: CCF-1139864, CCF-1136538, and CSI-1136536 and by the John Simon Guggenheim Foundation and the Richard T. Cheng Endowment.

References


Center for Real-Time Computing Group (CRTC)