3D-EPUG-Overlay: Intersecting very large 3D triangulations in parallel

W. Randolph Franklin
Rensselaer Polytechnic Institute
Troy NY USA 12180
mail@wrfranklin.org

&

Salles Viana Gomes de Magalhães
Rensselaer Polytechnic Institute & Federal U of Viçosa, Brazil
sallesviana@gmail.com

We present 3D-EPUG-Overlay, an algorithm and preliminary implementation for intersecting (aka overlaying) two 3D triangulations. This operation is important in processing large geometry datasets in additive manufacturing. Much of our algorithm is a sequence of map-reduce operations, and so is easily parallelizable. We completely avoid roundoff errors and the associated topological problems by computing with rational numbers. We will handle geometric degeneracies with Simulation of Simplicity (SoS). Our target architecture is an inexpensive workstation.

We have a complete 2D implementation, which has overlaid two 2D maps maps, with a total of 54,000,000 vertices and 739,000 faces, in only 322 elapsed seconds (excluding I/O) on a dual 8-core 3.4GHz Intel Xeon workstation. That time is using 16 cores, and is 11x faster than using one core. Our 3D implementation is complete except for SoS. It processes two 3D objects with a total of 6,000,000 face triangles and 3,000,000 tetrahedra in 180 elapsed seconds on 16 cores. The parallel speedup for 16 cores is a factor of 13. The execution time is almost linear in the data size, and could process much larger datasets, perhaps billions of triangles. We anticipate being able to process much larger datasets than competing SW can, and for datasets small enough for others to process, that we will be much faster and more robust on special cases.

---------------

W. Randolph Franklin is a Professor in the Electrical, Computer, and Systems Engineering Dept, Rensselaer Polytechnic Institute (Troy NY USA). His current NSF research project is to understand the mathematics of terrain.

His research hobby is designing and implementing small, simple, and fast data structures and algorithms for large geometric datasets. Note that efficiency in both space and time can become more important as machines get faster. This research is applicable to computational cartography, computer graphics, computational geometry, and geographic information science.

During 2000-2002 Franklin served a rotation to the National Science Foundation, as Director of the Numeric, Symbolic, and Geometric Computation Program. He was one of the prime movers of the two Computational Algorithms and Representations for Geometric Objects (CARGO) solicitations, joint between NSF and DARPA.

Franklin’s degrees are from Toronto (BSc, Computer Science), and Harvard (AM & PhD, Mathematica Accomodata).

Salles Viana Gomes de Magalhães is an instructor at the Federal U of ViÅ§osa, Brazil. He is currently pursuing a PhD at RPI.