Summary

Interaction has come to play an essential role in scientific visualization. It allows a scientist to explore large quantities of data derived from various sensor technologies as well as the output of complex simulations. These data are large enough to easily overwhelm even the most powerful graphics hardware available, making useful interaction with the data all but impossible.

One approach to achieving interaction is to trade fidelity for speed by employing multi-resolution forms of the visualization data. This ability to control the level of detail can bring many visualization applications from a state of non-interactive performance to one of interactive performance. However, if the data are complex enough, the quality may be reduced beneath the threshold of useful visualization during periods of interaction.

Another classic approach to improving performance is to build a faster machine. 3D rendering is a highly parallelizable problem, so a number of large-scale parallel machines have been built over the years to push the state of the art, allowing the visualization of larger data sets. Today’s parallel machines often take the form of networked clusters of PCs, built mostly from commodity parts. The typical emphasis and philosophy in the field parallel rendering focuses research on the hardware architecture’s scalability; then one builds a machine big enough to render the desired data. Such an approach is neither sufficient for rendering today’s largest data sets nor cost-effective for the increasing base of cluster users.

In this research project we have tightly integrate the use of level of detail with PC cluster-based rendering systems. As a product of this research, we have developed:

- **GLOD**, a widely deployable and publicly available level-of-detail system with a translucent, driver-level API supporting a variety of level of detail algorithms across a range of parallel rendering architectures.
- Level of detail algorithms for performing load management as well as load balancing of visualization clusters.
- Parallel algorithms for both level of detail construction and level of detail management.
- Level-of-detail approaches to data compression that are compatible with high-performance, highly parallel graphics hardware (GPUs)
- Debugging approaches leveraging visualization to explore large quantities of data within a modern parallel GPU

Students and Collaborations

This research project has also supported the development of a number of student researchers, including 3 PhDs (Krysztof Niski, Budirijanto Purnomo, and Yuan Chen, 1 MS (Nathaniel Duca), and 1 BS (also Nathaniel Duca). It enabled research discussions both remotely in person of the PI with DOE Researchers at LLNL: Randy Frank, Sean Ahearn, Mark Duchaineau, and Peter Lindstrom. These research collaborations have been so successful that the PI has actually joined the research team as an employee at LLNL.
Publications
This research project has resulted in a number of technical publications, listed below. Many are available via the world-wide web at:
http://www.cs.jhu.edu/~cohen/publications.html
In addition, the GLOD software is available at:
http://www.cs.jhu.edu/~graphics/GLOD


Proceedings of 2nd Eurographics/ACM Symposium on Geometry Processing, pp. 67-76.
2004. (acceptance rate: 29%)

Polygonal Mesh Simplification with Guaranteed Error Bounds.” International Journal of

14. Kumar, Subodh, Dean Snyder, Donald Duncan, Jonathan Cohen, and Jerry Cooper. “Digital
Preservation of Ancient Cuneiform Tablets Using 3D-Scanning.” Proceedings of Fourth
for cover image) (acceptance rate: 40%)

15. Chhugani, Jatin, Sudhir Vishwanath, Jonathan Cohen, and Subodh Kumar. ISOSLIDER: A
System for Interactive Exploration of Isosurfaces. Proceedings of the Joint Eurographics
rate: 48%)

“Perceptually Guided Simplification of Lit, Textured Meshes.” Proceedings of 2003 ACM
Symposium on Interactive 3D Graphics. pp. 113-121. (selected for cover image) (acceptance
rate: 26%)

17. Hahn, Daniel V., Donald D. Duncan, Kevin C. Baldwin, Jonathan D. Cohen, and Budirijanto
Tablets.” Proceedings of IS&T/SPIE 18th Annual Symposium Electronic Imaging and Science

Technical Sketches. accepted. 1 page.

ACM SIGGRAPH Technical Sketches. 1 page.

Fields on Curvilinear Grids Using a 3D Warp Texture.” submitted to ACM SIGGRAPH
Technical Sketches. 1 page.

Structured Grids Using a 3D Warp Texture.” IEEE Visualization 2004 Poster and Interactive
Demo. pp. 107-108. (received Best Poster Award out of 35 accepted posters).


Geometric Level of Detail System at the OpenGL API Level.” IEEE Visualization 2003 Poster
(2 pages). (received Best Poster Award out of 32 accepted posters).


25. Cohen, Jonathan D., David Luebke, Nathaniel Duca, and Brenden Schubert. “GLOD: Level of