

Visualization of large Iso-Surfaces based on nested clip-boxes

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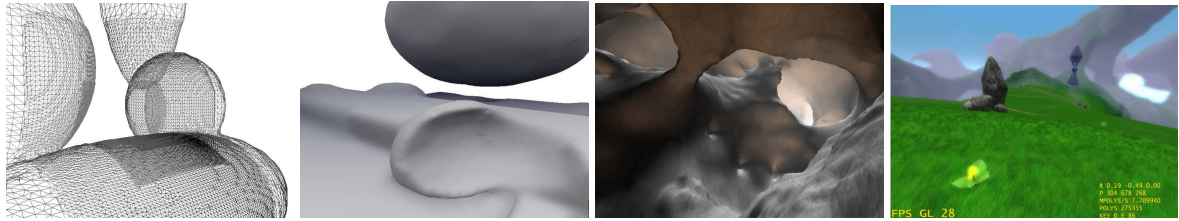


Figure 1: a) wireframe representation b) simple dataset shown by 3 clip-boxes c) cave example d) volumetric terrain

Abstract

Presented is a novel algorithm for the view-dependent visualization of large iso-surfaces in real-time. The presented method utilizes a unique continuous level-of-detail approach based on nested clip-boxes for visualizing the triangular geometry, shown in Figure 1. The algorithm focuses on simplicity and performance for fast rendering and continuous frame-rates. In tests, the peek frame-rate has been up to 120 for an un-textured mesh of about 100k polygons, consisting of 5 clip-boxes.

The work is inspired by the terrain rendering algorithm of [Frank Losasso 2004]. Losasso's approach uses geometry clip-maps for creating terrain mesh, rather than building a complex LOD hierarchy. The same approach is applied here, but for the three-dimensional case. The clip-maps are therefore changed to clip-boxes. While moving through the scene, the clip-boxes' positions are frequently updated according to the visitor. The most inner box needs to be updated most often, each following box half as often as its nested predecessor.

Almost all advantages listed in [Frank Losasso 2004] for the two-dimensional case are also valid for the presented, three-dimensional version:

- **Simplicity.** It is not necessary to manage any complex tree structure, as in [Lindstrom 2003], as well as [Benjamin Gregorski 2002], and also time consuming preprocessing is not required.
- **Optimal rendering throughput.** All geometry which is contained by a clip-box resides in Graphic-card memory for optimal performance. The finally generated triangle-strip structure allows rendering with optimal vertex-cache reuse.
- **Steady rendering.** The frame-rate will not change abrupt by moving through the iso-surface, as there are no sudden changes in the tessellation.
- **Immediate complexity adjustment.** Even if the borders of the clip-boxes are fixed, it is possible to adjust the clip-box borders for reducing the amount of rendered triangles on the fly.
- **Elegant degradation.** If the visitor is moving quickly, it might not be possible to update the most inner clip-box fast enough. In this case, as many clip-boxes as possible will be updated,

starting from the largest one. If there is no time left, higher levels of detail have to be skipped.

- **Memory usage.** As there are no additional data-values such as tree-structures or error-values for subdivision, the whole system is very memory friendly. In addition, compression applied to the volume data might be included for further improvement. The data which is requested by the algorithm for updating the clip-boxes is ordered in a certain manner and therefore better suited than algorithms acquiring data completely at random.
- **Synthesis.** The simple structure which is generated by the algorithm also allows an enhancement of the generated geometry with procedural details. Figure 1, part c and d, present artificial datasets where perlin noise has been applied. This feature is even applicable on the GPU directly, without any preprocessing.

CR Categories: I.3.7 [Three-Dimensional Graphics and Realism]: Visible line/surface algorithms—; I.3.5 [Geometric algorithms, languages, and systems]: Hierarchy and geometric transformations—;

Keywords: visualization , level of detail , iso-surfaces , large datasets

References

- BENJAMIN GREGORSKI, MARK DUCHAINEAU, P. L. V. P. 2002. Interactive view-dependent rendering of large isosurfaces. In *Proceedings of the conference on Visualization '02*.
- FRANK LOSASSO, H. H. 2004. Geometry clipmaps: terrain rendering using nested regular grids. In *Proceedings of the 2004 SIGGRAPH Conference*.
- LINDSTROM, P. 2003. Out-of-core construction and visualization of multiresolution surfaces. In *Proceedings of the 2003 symposium on Interactive 3D graphics*.

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