Grid-Based Ray Tracing for a Parallel Computing Architecture

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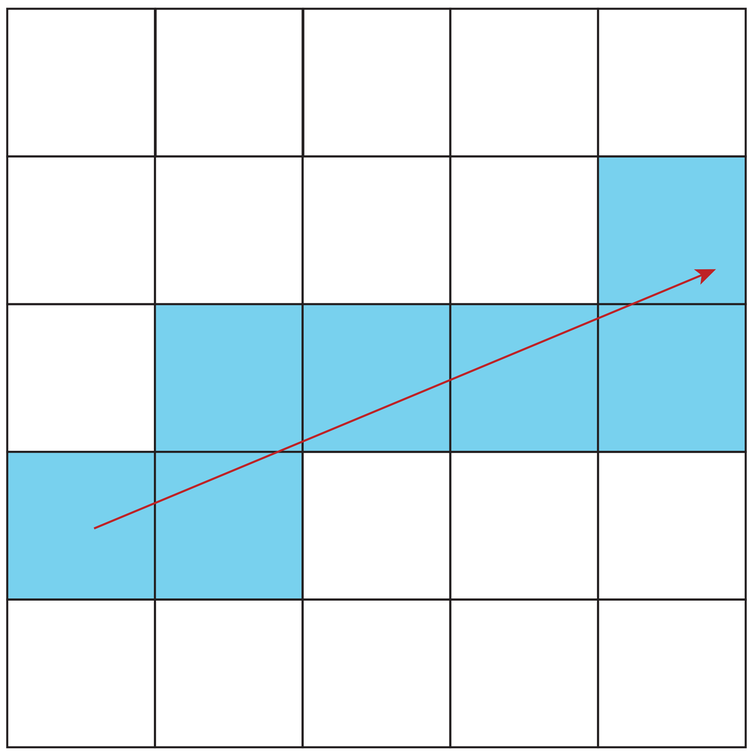
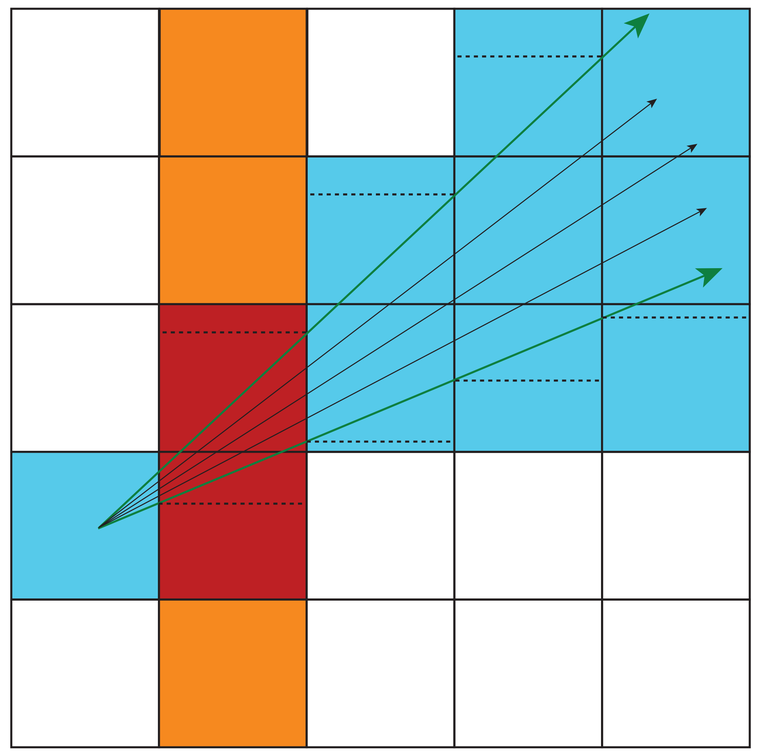
We propose a novel method for ray tracing on the GPU using a grid acceleration structure. Our approach is similar to (Wald et al)* in which they traverse a frustum of rays through the grid, using SSE 4-wide SIMD extensions. Our primary motivations for this work are:

- Simultaneous multiple frusta traversal in SIMD
- Novel partitioning of ray-triangle intersections that maps well to CUDA
- 3D digital differential analyzers (grid traversal) maps well to CUDA



Basic grid traversal - at each step, the ray moves to the next closest grid cell, intersecting the triangles in each.

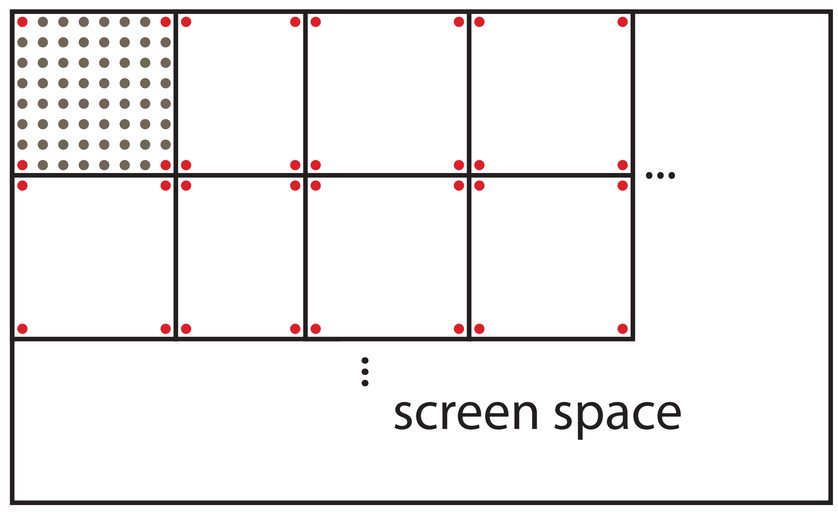


Frustum grid traversal - at each step, we move forward one slice (orange) along the major axis. We traverse all cells (red) within each slice that the bounding frustum overlaps.

Initial Performance Results

Scene	triangles	GPU FPS	CPU FPS	speedup
Cornell	32	133	0.5	266
Bunny	66454	44	0.18	244
Sponza	76087	17	0.08	212
Conference	282664	11.5	0.05	230
Soda Hall	2169132	26	0.1	260
Statuette	10000000	10.5	0.04	262

All scenes rendered at 512x512
- GPU results gatered on nVidia GTX280 video card
- CPU results gathered on AMD Phenom X4 2.0Ghz



Threads operate on frustum bounds (red dots) during the traversal phase, and on pixels (grey dots) during the intersection phase.

Ambient Occlusion

Ambient occlusion rays share a common origin and tend to be short, thus not traversing many grid cells in most cases.

- Grids do not require full top down traversal
  - -Can trace short ambient occlusion rays efficiently in SIMD
- 30% higer performance in terms of rays/sec

Future Work:

-Frustum culling

-Mailboxing

- -8 to 14 factor reduction in ray-triangle intersection tests has been shown*
- - Works effectively with coherent grid traversal*

*WALD, I . , IZE , T. , KENSLER , A. , KNOLL , A. , AND PARKER , S. G. 2006. Ray tracing animated scenes using coherent grid traversal. In SIGGRAPH '06: ACM SIGGRAPH 2006 Papers, ACM, New York, NY, USA, 485–493.