Multi-Level Hashed Grids for Ray Tracing

Vasco Costa  
vasc@vimm.iinesc-id.pt  

João Pereira  
jap@vimm.iinesc-id.pt  

Joaquim Jorge  
jaj@vimm.iinesc-id.pt  

INESC-ID / IST

Grids have some of the lowest ray tracing acceleration structure build times. Grids have O(N) construction time complexity regarding the number of primitives unlike other commonly used acceleration structures, such as kd-trees or bounding volume hierarchies, which have an O(N log N) lower bound. This trait makes grid ray tracing interesting for many applications including animation. Recent algorithmic developments have also made it possible to achieve one-level grid construction, with low memory requirements, by compressing empty grid cells. Unfortunately one-level grids achieve lower render time performance than recursive structures such as multi-level grids. We briefly describe a method for rapidly building a grid with similarly good render time performance and using less memory than classic multi-level grids. It proves to be a remarkably effective solution for interactive ray tracing of large scanned models.

function BuildMultiLevelHG(triangle[] T)  
V = BoundingBox(T)  
for all i ∈ {x, y, z}  
Mi = \frac{V_i}{\sqrt{32 \times \text{length}(T)}}  
olgrid = BuildOneLevelHG(M, T, V)  
macrocells = BuildMacroCells(olgrid, 6)  
return new mlgrid(olgrid, macrocells)

In the middle, is the 618 × 342 × 414 level 1 grid for the Asian Dragon (7.22 Min) at the left. At right, the 103 × 57 × 69 level 2 grid.

Multi-level hashed grids behave especially well for the larger tested scenes, with the most empty cells, having around twice the rendertime performance of one-level hashed grids described by Lagaë et al.1. These results are better than the 30% speedup for nonhashed grids reported by Wald et al.2.

In the left chart, acceleration structure build time statistics can be seen. At middle, the chart has render time statistics. At right are acceleration structure memory usage statistics for the tested scenes. Timings are the average of several test runs. All timings were done on a machine using a 3GHz Intel Core 2 Duo CPU. Only a single thread was employed. All images were rendered at a resolution of 1024 × 1024 with one ray per pixel and diffuse shading.


This work was supported by the Portuguese Foundation for Science and Technology project VIZIR.  
(PTDC/EIA/66655/2006)