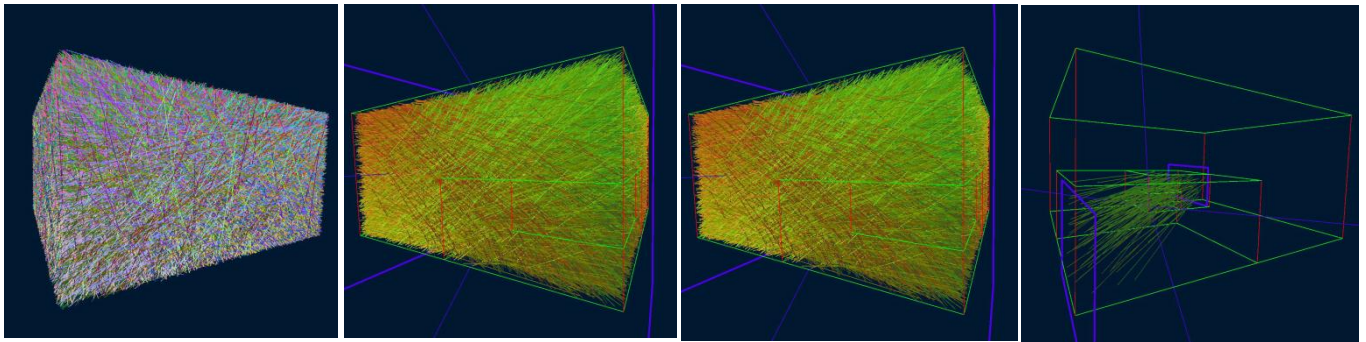


Accelerated 5D Ray Tree construction on the GPU

Ravi Kammaje

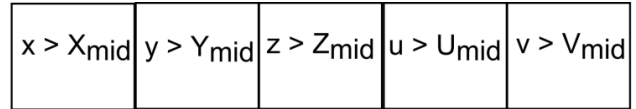
Benjamin Mora



(a) All the random rays (b) Top Level of tree (c) Node at Level 1 of tree (d) Node at Level 2 of tree

Fig. 1

Tree Building times	Random rays
CPU	451 ms
GPU	21 ms



5 bits determined as shown above indicate a ray's child node
Each node has 32 child nodes and the value of the specifies provides the child node

Fig. 2

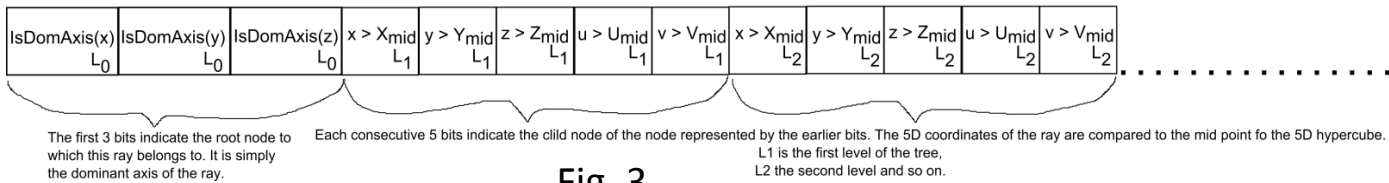


Fig. 3

Identify root nodes of ray tree

- Find dominant axis of rays.
 - Indicate
 - X as 0, +X as 1,
 - Y as 2, +Y as 3,
 - Z as 4 and +Z as 5
- Sort the rays of node
 - Ensures rays are together
- Count the number of rays in each node
- The range of the five dimensions is now:
 - X_{min} to X_{max} , Y_{min} to Y_{max} ,
 - Z_{min} to Z_{max} , $U(-1, 1)$, $V(-1, 1)$

References

[AK87] ARVO J., KIRK D.: Fast ray tracing by ray classification. *SIGGRAPH Comput. Graph.* 21 (August 1987), 55-64. 1

[GL10] GARANZHA K., LOOP C.: Fast ray sorting and breadth-first packet traversal for gpu ray tracing. *Computer Graphics Forum* 29, 2 (2010), 289-298. 1

[RAH07] ROGER D., ASSARSSON U., HOLZSCHUCH N.: Whitted ray-tracing for dynamic scenes using a ray-space hierarchy on the gpu, jun 2007. 1

[RSH05] RESHETOV A., SOUPIKOV A., HURLEY J.: Multi-Level Ray Tracing Algorithm. *ACM Transactions on Graphics (Proceedings of SIGGRAPH 2005)* 24, 3 (2005), 1176-1185. 1

[SHG09] SATISH N., HARRIS M., GARLAND M.: Designing efficient sorting algorithms for manycore gpus. *Parallel and Distributed Processing Symposium, International 0* (2009), 1-10. 2

[WS01] WALD I., SLUSALLEK P.: State of the Art in Interactive Ray Tracing. In *State of the Art Reports, EUROGRAPHICS 2001*. EUROGRAPHICS, Manchester, United Kingdom, 2001, pp. 21-42. 1

Build the lower levels of the ray tree

- Find mid point of each active node (five dimensional hypercube)
 - X_{mid} , Y_{mid} , Z_{mid} , U_{mid} , V_{mid}
- Classify each ray
 - 5D representation (x, y, z, u, v)
 - Find orientation with respect to mid point of node
 - Use 5 bits to represent this. (As shown above)
- Sort the rays of node
 - Ensures rays are together
- Count number of rays in each node
 - If any nodes contains fewer than leafNodeRays, make it a leaf node. i.e. do not divide it further
 - Continue until all nodes are leaf nodes

- Sorting is very expensive, even on GPUs
- To optimize, find full classification as shown in Fig(3)
- Sort this 32 bit integer and use 5 bit values for current level.
- Replace highlighted step with a simple lookup.