Accelerated Ray Tracing

- Fast intersection computation
- Spatial Subdivision
- Higher dimensional subdivision
- Memory coherency

Fast intersection computation

- Optimized code
- Spheres
- Bounding boxes
  - Axis aligned
  - Oriented (transform rays - Rubin & Whitted)
- Slabs forming convex hulls
- Hierarchies
  - Higher order objects
  - Object clusters

Spatial Subdivision

- Uniform - Fujimoto
- Multilevel - Jevans
- Hierarchical - Octree (Quadtree)
- BSP tree
- Dealing with multiple hits

Higher Dimensional Spaces

- Space-time for canned animations
  - S(x,y,z,t), coherence wins
- R^3 x S^2 - 5D ray classification
  - Light buffer (scan conversion on faces)
  - Ray classification with limited reach
  - lazy evaluation
- Ray bundling - safety zones

Parallel implementations

- SIMD/Vector machines
  - Karl Sims - Connection Machine
  - Nelson Max - Cray
- MIMD
  - Distribute rays - scene data replication
  - Distribute data - sending rays over interconnect

Memory coherency

- Handling huge scenes - too big for memory
  - Caching in modern architectures
  - Cost of random accesses - cache misses
- Coherent storage in voxels
  - nearby rays hit same objects
- Reordering computation to bundle rays
  - Massive SIMD machine issues
  - Caching performance, from disk

Toward Real-Time Ray Tracing

- Tailored memory allocation
  - a priori knowledge of chunk size, etc.
  - Geometry Cache, Texture Cache
- In-place geometry expansion
  - Higher order surfaces, displacement maps
- Hardware acceleration
  - ART
  - Embedded DRAM

Upcoming lectures

- 4/27 Color - Maureen Stone
- 4/29 Radiosity - Don Greenberg
- 5/4 More Radiosity - Greenberg

References

- Chapter 6 in the Glassner text
- [Fujimoto86] A. Fujimoto, T. Tanaka, K. Iwata, "ARTS: Accelerated Ray Tracing System", IEEE Computer Graphics and Applications, 6 (4), April. 1986, pp. 15-26.
- [Glassner84] Andrew Glassner, "Space Subdivision for Fast Ray Tracing", IEEE Computer Graphics and Applications, 4 (10), Oct. 1984, pp. 15-22.
- [Glassner88] Andrew Glassner, "Spacetime Ray Tracing for Animation", IEEE Computer Graphics and Applications, 8 (2), March 1988, pp. 60-70.
- [Jevans89] David Jevans and Brian Wyvill, "Adaptive Voxel Subdivision for Ray Tracing", Proc. Graphics Interface '89, June 1989, pp 164-172..

More References

- [Arvo87] James Arvo and David Kirk, "Fast Ray Tracing by Ray Classification", Proc. Siggraph '87, Computer Graphics, 21(4), July 1987, pp. 55-64.[Kay86] Tim Kay and Jim Kajiya, "Ray Tracing Complex Scenes", Proc. Siggraph '86, Computer Graphics, 20(4), August 1986, pp. 269-278.
- [Delaney88] Hubert C. Delaney, "Ray Tracing on a Connection Machine", Proc. Int. Conf. on Supercomputing, St. Malo, France, July 1988, pp. 659-667 (available from ACM, Order No. 415881)
- [Pharr97] Matt Pharr , Kolb, Gershbein and Hanrahan, ”Rendering Complex Scenes with Memory-Coherent Ray Tracing", Proc. Siggraph ’97, August 1997, pp. 101-108