Accelerating Ray Tracing

Ray Tracing Acceleration Techniques

- Faster Intersections
  - Faster Ray-Object Intersections
    - Object bounding volumes
    - Efficient intersection routines
  - Bounding volume hierarchies
  - Frustum culling
  - Space subdivision
  - Directional techniques
- Fewer Rays
  - Fewer Ray-Object Intersections
    - Adaptive tree depth
    - Statistical optimizations
- Generalized Rays
  - Beam tracing
  - Cone tracing
  - Pencil tracing

Bounding Volumes

Simple volume description guaranteed to contain a more complex volume description

Test ray against more complex primitive only if it intersects bounding volume

Increases time for hits, but reduces time when ray misses bounding volume

Provide bounds on interval of intersection

Bounding Volume Examples

Sphere

Axis-Aligned Bounding Box

Oriented Bounding Box

General Slab Intersection
Bounding Volume Hierarchies

Cluster bounding volumes hierarchically

Only intersect ray with child volume if it intersects parent

Reduces number of ray-volume and ray-object intersection tests
Bounding Volume Tree

Computing Hierarchies

Top-down

Bottom-up

Minimize volume/surface area

Computing “good” hierarchies is difficult
Space Partitioning

Break model space into chunks

Pre-compute which objects overlap each chunk

Trace rays through chunks

Only intersect rays with objects stored in current chunk

Typically only allow each ray-object intersection once (not in multiple chunks)

Types of Space Partitions

Uniform

Octree

K-d tree

BSP Tree
Tracing through a Space Partition

Incrementally

• trace along ray, walk from partition to partition
• difficult except for uniform partition
• other partitions may require augmented data structures

Top-down

• intersect ray with each of node’s children
• traverse children it intersects

Frustum Culling

Cull all bounding volume nodes that lies outside current viewing frustum

Probably not necessary if using space partition
Frameless Rendering

Double buffering - wait for all pixels to display image
  • Slowly displays old images

Frameless rendering - display all pixels immediately
  • Quickly displays partially-updated images

Applicable to interactive applications requiring low latency and high performance

Frameless Rendering Example

All pixels updated at 5 Hz
33% pixels updated at 15 Hz

Interactive Ray Tracing

Experiments run on high-end parallel machine

- Scales to hundreds of processors on SGI Origin 2000
- Scalability limited only by load balancing and synchronization

Can employ frameless rendering

Interactive Ray Tracing Video

Questions about Assignment?

Input colors [0.0-1.0]
  • Output colors [0-255]

Eye space
  • Looking down -Z axis

Viewing plane
  • Distance is irrelevant

File format
  • Assume lines not broken up