ARTS: Accelerated Ray-Tracing System
Background

• Ray tracing is computationally expensive
  ▫ For simple scenes 75 percent of the total time is spent on calculating intersections

• Researches concentrated mainly on reducing the complexity of intersection calculation.
  ▫ shapes of the extents
  ▫ hierarchical relations between extents
  ▫ level of coherency that is exploited
3D DDA

Purpose:

- A totally incremental tool for traversing the data structure.

- The structure in the paper is:
  - Octree
  - Spatially Enumerated Auxiliary Data Structure (SEADS)
Modification on DDA

DA - Driving axis
PA - Passive axis

\[ S = \frac{dx}{dy} \]

- Cells identified by DDA in line generation
- Additional cells pierced by a straight line
3DDDA with SEADS

- **SEADS**: A 3D extension of the raster grid with pixels becoming voxels.

- Identify SEADS voxels pierced by a ray. Using two synchronized DDA's working in mutually perpendicular planes.

- All of the segments a cuboid is contained is checked for intersection.

- Ray trace stops if some object is intersected or it leaves the mesh domain.
3DDDA with SEADS

PA - Passive axis
DA - Driving axis
C - Control term

\[ S_1 = \frac{\partial z}{\partial x} \quad S_2 = \frac{\partial z}{\partial y} \]
Octree

• The data are stored in a hierarchical tree structure with nodes representing disjoint cuboids of geometrically decreasing size.

• Require a large memory:
  ▫ store a 2D quadtree object is on the order of the perimeter of the object
  ▫ store a 3D octree object is on the order of the surface area of the object
Octree encoding
Traversing the octree

• Horizontal traversal
  ▫ Happens when moving to an adjacent cuboid.
  ▫ Terminated when any of the three indices overflows or underflows.

• Vertical traversal
  ▫ Happens when the ray is trying to leave a node.
Experiments

- VAX 11/750 (4M-byte CPU) under the VMS operating system.
Experiments

- two hours and 15 minutes to generate

- VS.

- 40 days for traditional ray tracing
Results

• Calculation time is only very slightly influenced by the number of objects in the scene.

• Octree encoding would have an advantage for cases where high scene coherency results in a large percentage of empty areas.

• All advantages of octree are outpaced by the cost of vertical traversing.

• Unless the octree-encoded structure can be traversed rapidly enough, pure octree encoding may not necessarily speed up the calculations.
Thank you!