GPU Accelerated Tandem Traversal of Blocked Bounding Volume Hierarchies

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Traditional BVH Traversal

- Two BVHs are traversed
  - Using either a stack or a queue
  - Using a descend rule descending either tree
  - Descend both trees simultaneously

- For each descend, the BVs in the nodes are compared for overlap
Naive BVH on GPU

- One pair of BVHs per Thread
- Upper space bound for stack

\[ k (c - 1) \max (\text{height}(A), \text{height}(B)), \]

max. cardinality, \( c \), and size of two BV node references, \( k \).

Shared memory too small and global memory too slow
Use Blocks

- 1 Block $\equiv$ Each node has 4 children
- If overlap $\Rightarrow$ 16 new overlaps

Less data to transfer and more work per thread
Use Double Buffered List

Stack/Queue ⇒ Double buffered list

input pairs

k'th Pass

output pairs

Swap input/output pairs for next pass
Memory Trick Needed

- Thread idx
- Input pairs
- K'th Pass
- Hit flags
- Prefix sum
- Collect
- Output pairs

2 x 16 pairs
Need Imaginary Nodes

Less than 4 children ⇒ fill with imaginary nodes

Fills up space ⇒ part of calculation time ⇒ use sparsely
Blocks with Mixed Internal or Leaf Nodes

Not allowed $\Rightarrow$ Simpler code
Internal Block versus Leaf Block

if collide \((a, k)\) ⇒ push \((e, k)\)
if collide \((a, l)\) collision ⇒ push \((e, k)\)
if collide \((a, m)\) collision ⇒ push \((e, k)\)
if collide \((a, n)\) collision ⇒ push \((e, k)\)

Redundant results ⇒ add extra check to code
The Test Setup

Three different configuration types

- Structured stack
- Unstructured Pile
- Rock Slide
The Test Setup (Cont’d)

- For each configuration type
  - Increasing number of triangles in objects
  - Increasing number of objects
- Test against Rapid
  - Rapid uses OBBs we use AABBs
- No optimization of imaginary nodes in BVHs (upto 33%)
Results

Rapid on Intel Quad CPU using one core

Stack: Rapid

Pile: Rapid

Rockslide: Rapid

Cuda on ge9800 GX2 using one core

Stack: Cuda only

Pile: Cuda only

Rockslide: Cuda only

Stack (5-8)  Pile (3-7)  Slide (2)
Thanks

Questions?