Acceleration Data Structures for Ray Tracing

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Outline

- Ray tracing
- STAR
- Aims
- Results

Motivation

Figure: [PFHA10] Jacopo Pantaleoni, Luca Fascione, Martin Hall, and Timo Aila. Pantaray: Fast ray-traced occlusion caching of massive scenes. ACM Trans. Graph., 29(4):37:1-37:10, 2010.

Complexity

- 15min per frame
  - Over 6 years to render a movie
  - 4,000 Hewlett-Packard servers (35,000 processor cores)
- Ever increasing demand for
  - Complex scenes
  - Higher resolution (stereo)
  - Sophisticated effects

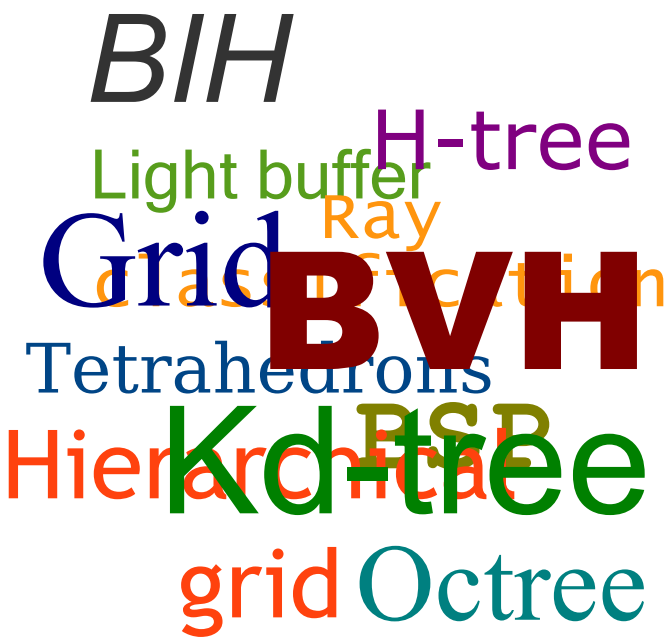
Computing the image

- Naive tracing
  number of rays $\times$ number of triangles
  #ray $\times$ #triangles $\Rightarrow$ Quintillions OPs (unbearable)
- With acceleration data structure
  number of rays $\times$ *log*(number of triangles)
  #ray $\times$ *log*(#triangles) $\Rightarrow$ Billions OPs

Acceleration Data structures

Light buffer

Acceleration Data structures



Surface Area Heuristic

- Goldsmith and Salmon [GS87]
- Standard method
- Probability of intersecting a box
- Guides the division of triangles
- Greedy heuristic

Research

- Faster traversal
- Faster build
- STAR [Wal07]

Traversal

- Improving SAH cost
- Soupikov et al. [SSK08]
- Popov et al. [PGDS09]
- Stich et al. [SFD09]

Build

- Asymptotical complexity
  - Wald and Havran [WH06]
  - Hunt and Mark [HMS06]
- Parallelization CPU
  - Wald [Wal07]
  - Choi et al. [CKL+10]
- Parallelization GPU
  - Lauterbach et al. [LGS+09]
  - Pantaleoni and Luebke [PL10]

Aims

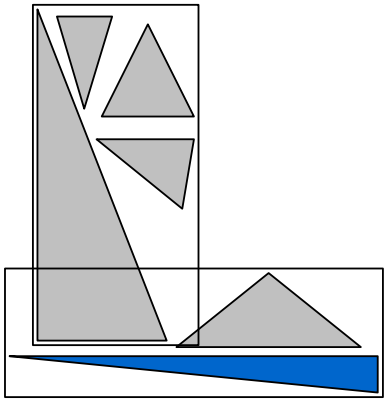
- Better acceleration data structures
- Higher traversal performance
- Realtime on commodity hardware

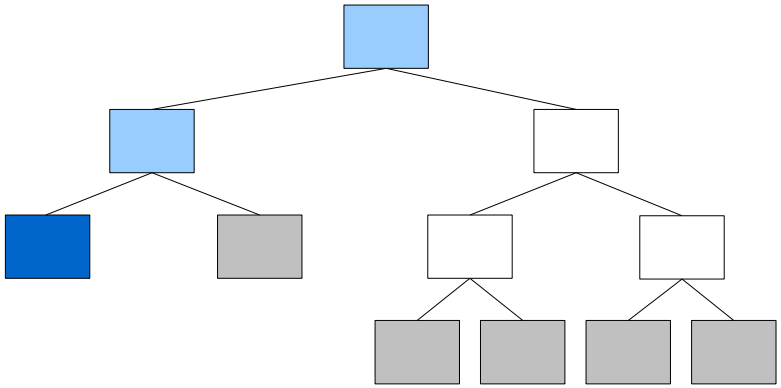
Plan

- Journal paper in 2011
- Conference paper in 2012
- Framework for students

Occlusion SAH

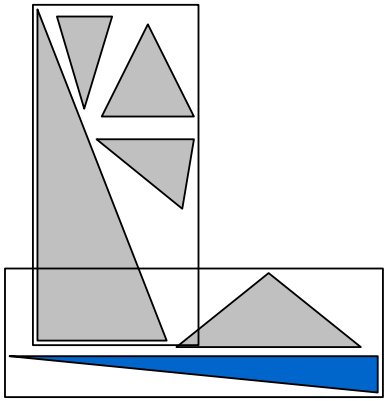
SAH

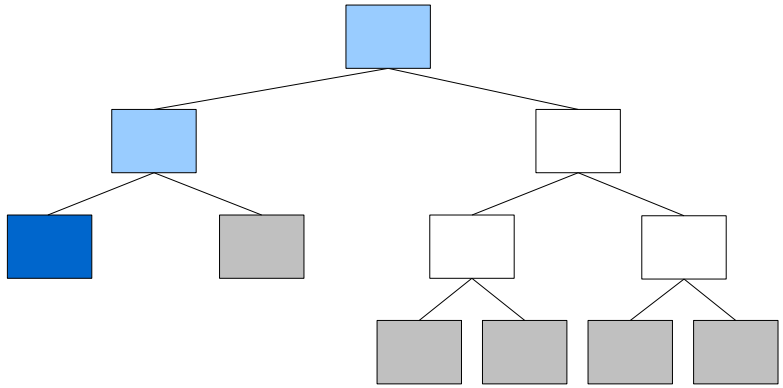




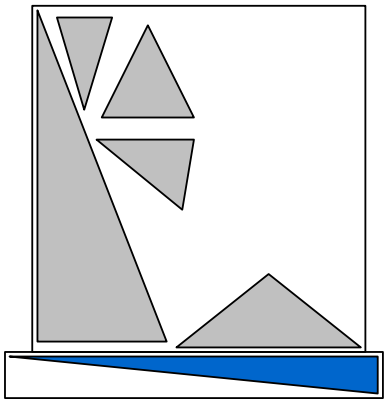
Occlusion SAH

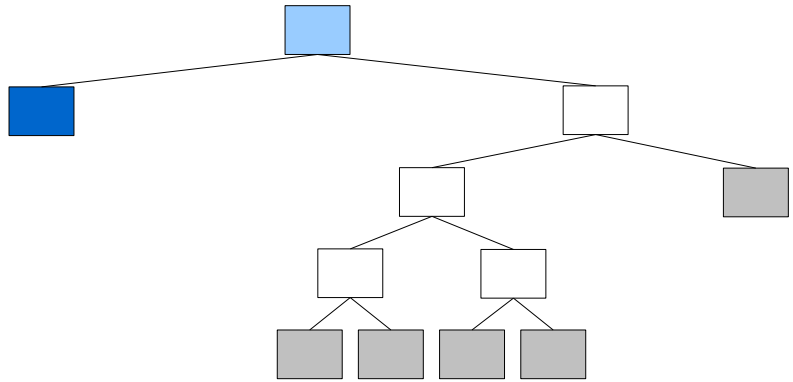
SAH



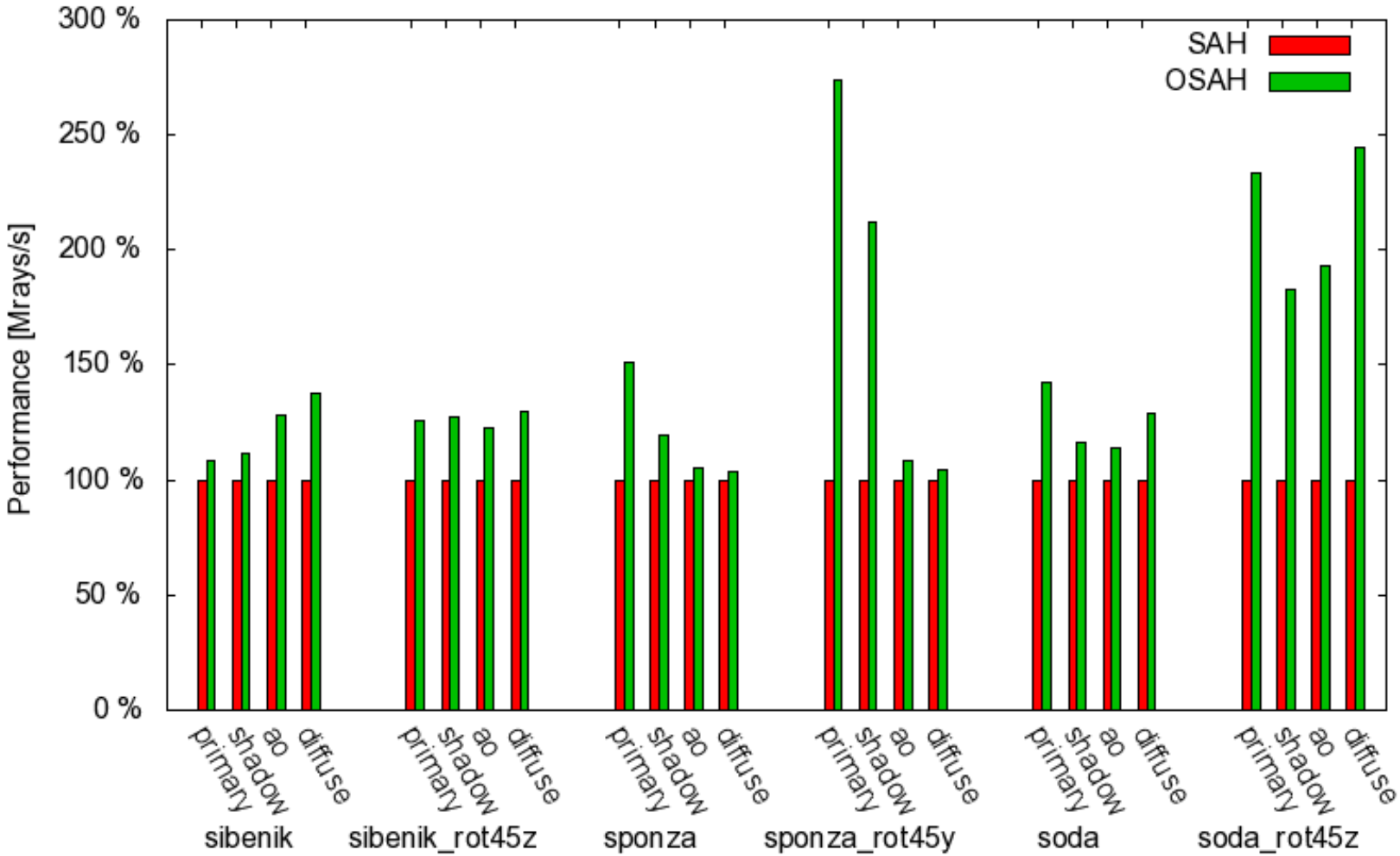


OSAH

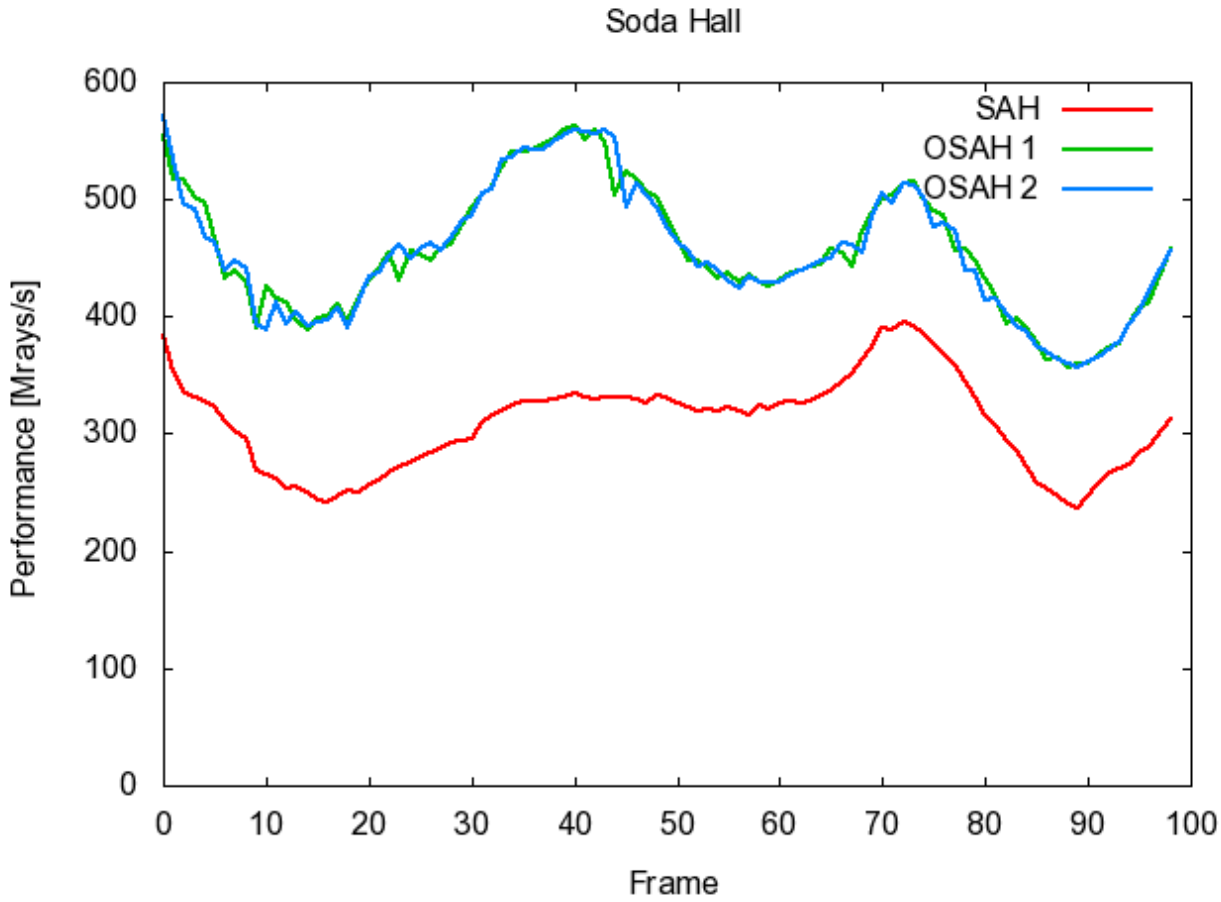




Results


Performance [Mrays/s]
300 %
250 %
200 %
150 %
100 %
50 %
0 %
SAH
OSAH
primary
shadow
ao
diffuse
sibenik
sibenik_rot45z
sponza
sponza_rot45y
soda
soda_rot45z

Acquiring visibility



Summary

- High quality images
- Costly to compute
- Optimizations
- Visibility

Any question?

Thank you!

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