A Spatial Representation for Ray-Scene Intersection Test Improvement in Complex Scenes

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ABSTRACT

We present a spatial representation based on a hierarchical structure using the well-known spatial indexing structure called octree. There are very useful spatial representations for scenes whose objects can be distributed in clusters and here we present a new one. In order to prove its benefits, several results are shown in scenes using a photon tracing algorithm to compute the global illumination based on photon map. These results show that the hierarchy of octrees becomes a good choice to improve the performance when compare to other strategies such as octrees and hierarchy of uniform grids [Caza95].

Keywords: *Acceleration techniques, ray casting, spatial indexing methods.*

1. Introduction

• An acceleration techniques core still being necessary in a Rendering System to minimize the required time for the ray-scene intersection test process.

• Several acceleration techniques have been proposed: 3D Grid, Octrees, Rectilinear BSP Tree.

• These techniques have very useful for different scenes: objects with several sizes and with a non-homogeneous distribution.

2. Previous Work

• We adopt a complex scene when it has a great amount of objects.

• A relevant contribution was proposed by Cazals et al [Caza95].

• The authors presented a spatial representation based on a regular grid called Hierarchy of Uniform Grids (HUG).

1. *A classification by size of the input objects is done.*
2. *A clustering step is applied to objects which are the same size.*
3. *A hierarchy of regular grids is built for each cluster.*

3. The Hierarchy of Octrees

• The Hierarchy of Octrees (HOO) uses the same advantages of the clustering process proposed by Cazals.

• The only different is that in the third step an octree is built for each cluster.

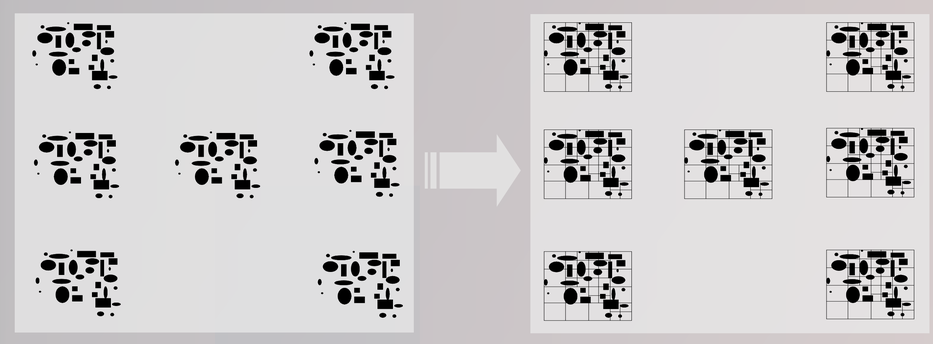


Figure 1. Scene grouped in 7 clusters

• **Problem**: Scenes which are matched as an only cluster.

Advantages using a Hierarchy of Octrees

• Less memory is required using a HOO than a simple spatial representation (i.e. an octree o a regular grid).

• As the space between clusters increases, so does the performance difference between an octree and a HOO.

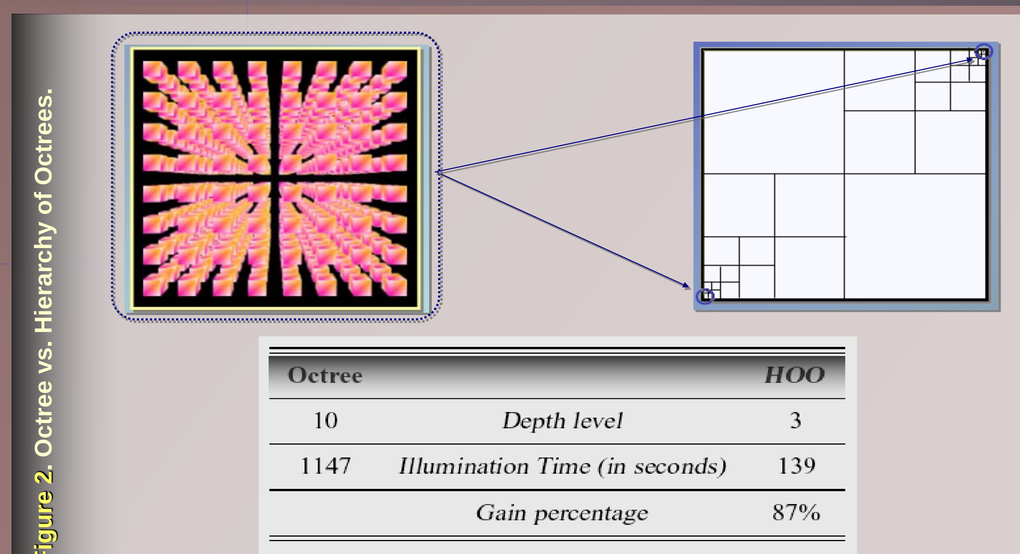
• A HOO provides better results than an octree and a HUG.

The main **disadvantage** of a HUG and a HOO is the required time for the clustering process.

4. Results

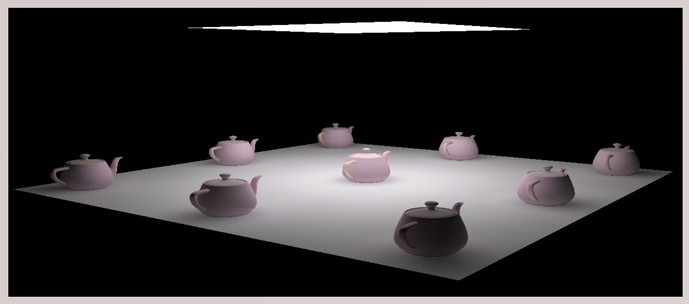
• In order to show the performance of the proposed spatial representation, two comparisons and scenes has been deployed.

1. Octree vs HOO (see figure 2). This comparison shows the gain in memory usage and time for the illumination process
2. HOO vs. HUG (see figure 3). This comparison shows the gain percentage using similar memory amounts in both cases.



Octree		*HOO*
10	*Depth level*	3
1147	*Illumination Time (in seconds)*	139
	Gain percentage	87%

Figure 2. Octree vs. Hierarchy of Octrees.



HOO depth level	Time	%	Time	*HUG* Subdivisions
4	**64.55**	21%	**81.23**	13
5	**52.19**	35%	**80.10**	21
6	**48.73**	39%	**80.26**	29
7	**48.74**	39%	**80.35**	37
8	**49.35**	38%	**79.34**	45
9	**49.97**	38%	**80.51**	53

Figure 3. Hierarchy of Octrees vs. Hierarchy of Unif. Grids.

5. Conclusions & Future Work

• The HOO provides similar **advantages** and **disadvantages** than the HUG.

• Spatial representations based on a HOO are very appropriated to use in cluster oriented scenes, specially when the clusters are far apart.

• In the photon tracing process, better results are obtained using a HOO than a HUG as it can be seen in figure 3.

As a future work, we are planning to prove the efficiency of a HOO in scenes with different distances between clusters and in more complex scenes.

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