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Visibility Preprocessing Using Spherical Patch Sampling

Visibility Preprocessing

We present a technique to speed-up rendering of poygonal meshes by efficiently discarding regions of the model which are occluded by the visible geometry of the model.

The technique consists of 3 steps:

1. Patch Tiling
2. Spherical Patch Sampling
3. View-Reconstruction / Rendering

Patch Tiling

At the beginning of this stage, every polygon of the model constitutes a patch. Then, the algorithm iteratively performs patch fusion until a desired patch count is reached. On every iteration, the smallest patch is extended by fusing it with its smallest neighbor.

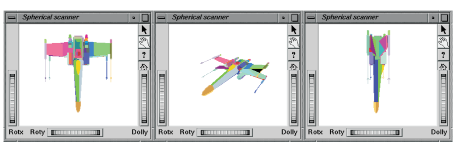
Tiling the model in patches has the following advantages:

- Image-based sampling of patches is more reliable than sampling of individual polygons.
- The visibility encoding file used for rendering is significantly small, since only one bit per patch is stored for each sample.
- During rendering, we include or discard elements using patches as the rendering primitive, which greatly increases the efficiency of the process.

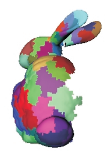
Spherical Patch Sampling

In this stage, images of the model are taken from several points on the surface of a sampling sphere that contains the model. To define the sampling points we use the vertices of a tessellated sphere which is produced by subdividision and reprojection of a base octahedron. The number of sampling points depends on the subdivision level selected.

A sampling program takes pictures of the model from each point of the sampling sphere and encodes the visibility information in patch- bitfields which are then stored in visibility files used during rendering.



The patch sampling program



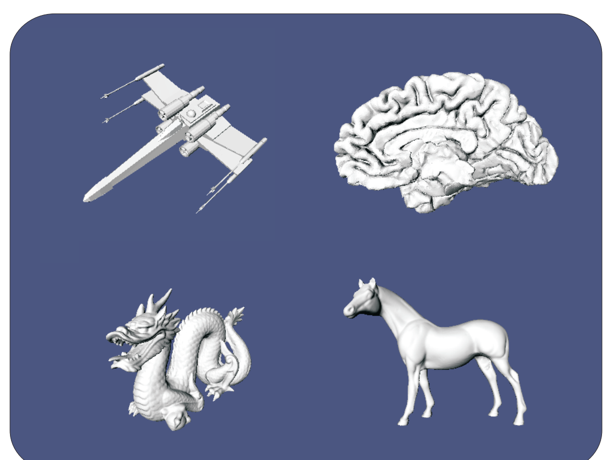
Side view of an image-based sample

Results

The following table illustrates improvements obtained in frame rate for several models:

Model	Polygons	Patches	Culling rate	Original f.r. (fps)	Optimal f.r. (fps)	Frame rate Improvement
Bunny	69,451	50 - 1000	15 - 60 %	24.9	36.0	50%
Horse	96,966	400	38%	19.8	30.7	55%
Dragon	871,414	600	44%	2.2	3.6	67%
Human Brain	288,334	1000	66%	7.4	18.0	144%
Hand	654,666	1000	38%	2.8	4.0	43%

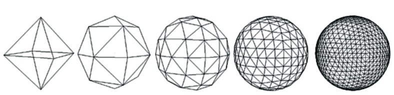
The reconstructed views are identical to the views produced when the complete model is rendered, as shown below.



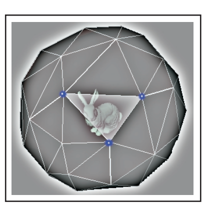
View Reconstruction - Rendering

To reconstruct the view of a model from an arbitrary viewpoint, the viewer module first determines which face of the viewing sphere is intersected by the viewing ray.

Using a bit operation, the visibility information of the three vertices connected to the intersected face (highlighted below) is used to compose the new view. This process is efficiently done in real-time.



Sphere tessellation by Paul Bourke



Reconstructed view from the three vertices of the highlighted face.

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