



Game Engine Architecture IT3935

Lecture 2



Summary

- 3D Pipeline Process
- Culling Techniques
- MultiSampling



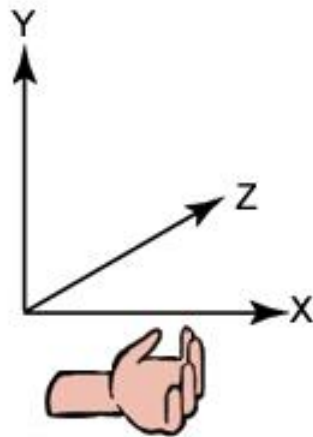
3D Pipeline Process

- How does 3D world gets rendered to 2D on the screen?

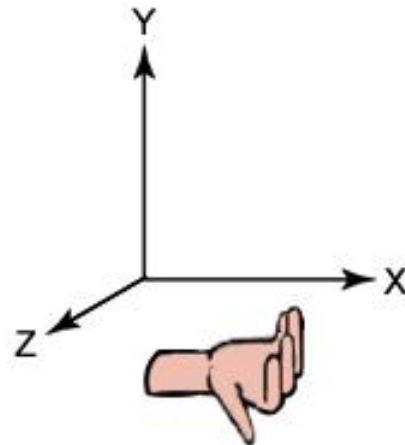
3D Cartesian Space

- Define a 3D coordinate system

Left-handed
Cartesian Coordinates



Right-handed
Cartesian Coordinates



3D space

- Model Space
Each model is in its own local coordinate system
- World Space
The unified coordinate system of the world where models are placed
- Screen Space
3D image converted to 2D image after normalizing the view frustum into a cube

Model Space

- 3D Artist create model in modeling software



<http://www.tnt.uni-hannover.de/js/project/3dmod/multview/wireframe.html>

World Space

- Model is loaded and rendered in the 3D world based on position, rotation and scale transform
- Application decides to render model or not based on its visibility in the scene, a process known as culling.
- Culling is performed because video card cannot handle all the polygons, so the application optimizes by sending only visible polygons to the GPU.

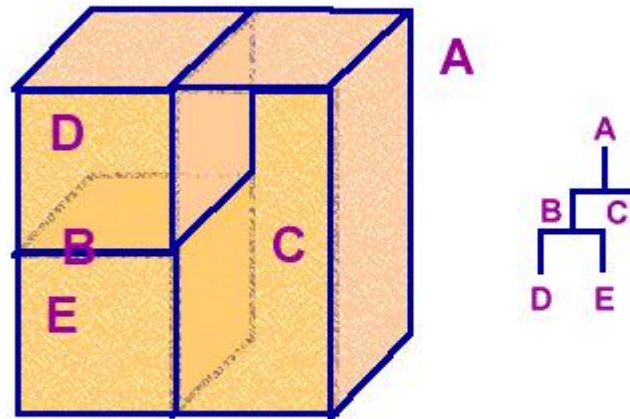
Culling Techniques

- Scene Graph – BSP, Portal
- View Frustum Culling
- Occlusion Culling
- Usually combined depending on scene

Scene Graph

- BSP, Portal, OctTree

BSP Tree Hierarchy

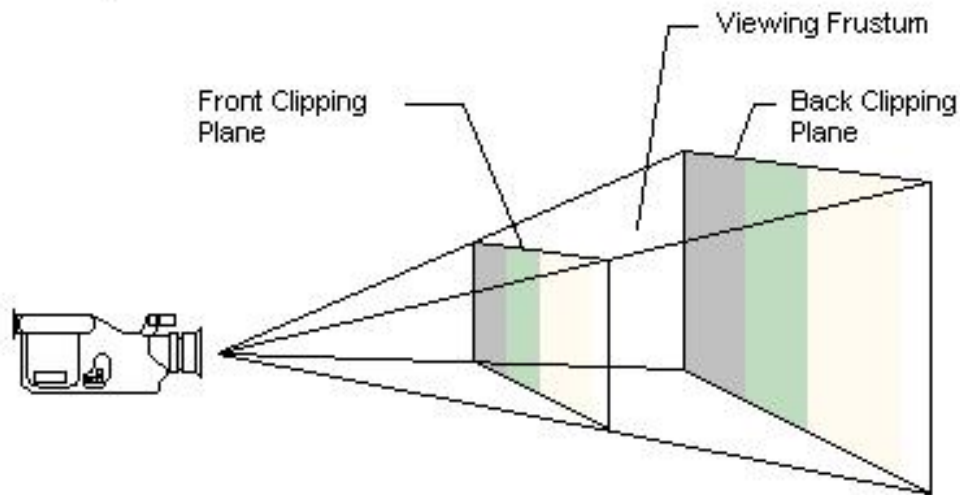


Source:

<http://www.martinb.com/threed/solidmodel/spatialdecomposition/bsp.htm>

View Frustum Culling

- Model has a simple bounding volume (usually sphere) to test against view frustum



Occlusion Culling

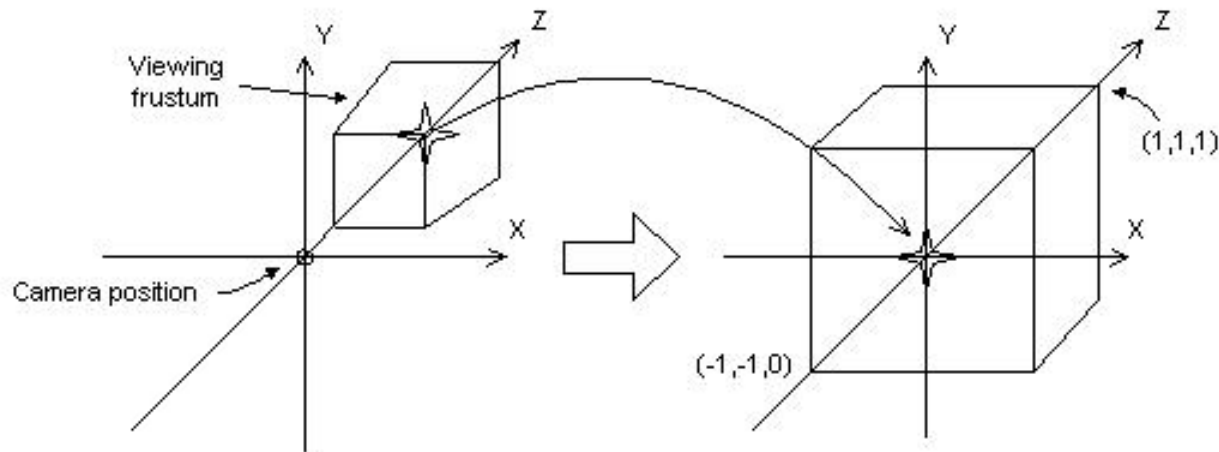
- A test to determine if an object is completely occluded (covered) by another object in front of it.
- One simple example of occlusion culling (at pixel level) is depth buffer

LOD

- After deciding to render model, choose the level of detail based on distance from viewer
- A far away object can be drawn using a model with less detail (lower polygon). When a object is close, then draw using a higher detailed model.

Screen space

- By applying the projection matrix, the model is transformed from 3D world space to 2D screen space
- The view frustum is normalized to a cube



Screen space

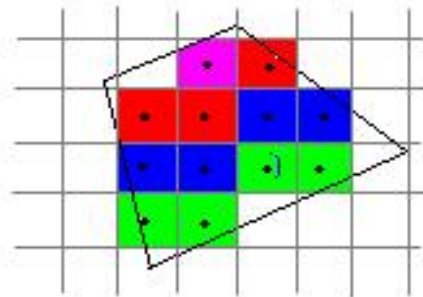
- Additional culling performed is back face culling and clipping
- Back face culling rejects polygons facing away from camera. It can also be performed in world space.
- Clipping is further remove polygons outside the viewport. Usually set to screen size.

Screen space

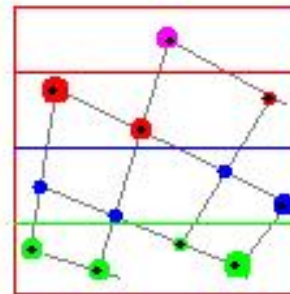
- After finishing transforming the model, we can shade and light the model.
- Different shading models are commonly used like Flat, Gourad, and Phong
- The final pixel color on the 2D screen is calculated based on shading, lighting and texture data.

Multisampling Techniques

- When texture map (texel) doesn't map directly to screen pixel, it results in blockiness known as aliasing



Screen



Texture

Multisampling Techniques

- Solution is to average out surrounding texels

Point sampling

Bilinear filtering

Trilinear MIP mapping

Anisotropic filtering

Antialiasing

AntiAliasing

- AntiAliasing is to temporary increase the screen resolution much higher, gathers an averaging of neighbouring pixels, and calculates the final pixel color
- Eg. FSAA (Full Screen AnitAliasing) for a 800x600 screen
 - 2x Sample 2X on one axis to 800x1200
 - 4x Sample 2x on both axis to 1600x1200
 - 9x Sample 3x on both axis to 2400x1800
 - 16x Sample 4x on both axis to 3200x2400
- Very performance intensive operation



End

- Questions?