CSC418 Computer Graphics

- Polygon normals
- Back Faces
- Visibility Algorithms

Polygon Normal

- Triangle normal calculation
- Polygon normal calculation
- Polymeshes (vertex normals)
Polygon Normal

- Triangle normal calculation

\[ \mathbf{N} = (\mathbf{P}_2 - \mathbf{P}_1) \times (\mathbf{P}_3 - \mathbf{P}_2) \]

Polygon Normal

- Polygon normal calculation

\[ \mathbf{N} = (\mathbf{P}_2 - \mathbf{P}_1) \times (\mathbf{P}_3 - \mathbf{P}_2) \]
Polygon Normal

- Polygon normal calculation

\[ N = (P_2 - P_1) \times (P_3 - P_2) \]

Problems

- Sliver triangles
- Non-planar polygons

\[ \begin{align*}
N_x &= \sum (y_j - y_i)(z_j + z_i) \\
N_y &= \sum (z_j - z_i)(x_j + x_i) \\
N_z &= \sum (x_j - x_i)(y_j + y_i)
\end{align*} \]

\[ j = (i + 1) \mod n \]
- Face normals

- Vertex normals
Polymesh Normal

- Vertex normals

average the face normals

Bilinear Interpolation

\[
P_{uv} = (1-u)(1-v)P_0 + (u)(1-v)P_1 + (u)(v)P_2 + (1-u)(v)P_3
\]
Bilinear Interpolation

Gourard shading (color interpolation)

\[ P_{uv} = (1-u)(1-v)P_0 + (u)(1-v)P_1 + (u)(v)P_2 + (1-u)(v)P_3 \]

Visibility Problem

- What is NOT visible?
Visibility Problem

- What is NOT visible?

  primitives outside of the field of view
  back-facing primitives
  primitives occluded by other objects closer to the camera

Backface culling
Backface culling
Backface culling

- $N \cdot V > 0$ is a back face?

Backface culling

- $N \cdot (P - E) > 0$
Backface culling

Where in the graphics pipeline can we do backface culling?

Occluded faces

Does backface culling always determine visibility completely for a single object?
Occluded faces

- In typical scenes some polygons will overlap, we must determine which portion of each polygon is visible to eye!

Painters Algorithm

- Sort primitives in Z.
- Draw primitives back to front (CBA).
Painters Algorithm

- Problems
  - Large faces
  - Intersecting faces
  - Cycles

Visibility Problem

- Image space algorithms
  - Operate in display terms pixels, scanlines
  - Visibility resolved to display resolution
  - Examples: Z-buffer, ray-tracing
  - $O(n \times \text{resolution})$

- Object Space algorithms
  - Analytically compute visible fragments
  - Examples: painters algorithm, BSP
  - $O(n^2)$
CSC418 Computer Graphics

- Next Lecture
  - BSP trees
  - Depth sorting
  - Z-buffer A-buffer