Moderovacie a renderovacie techniky

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https://github.com/frantisekdracek/Prezentacie/tree/main

Clipping

- Perspective projection in simple form:

$$\mathsf{P} = \begin{bmatrix} d & 0 & 0 & 0 \\ 0 & d & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{1}$$

- projected $\tilde{z} = \frac{1}{z}$
- problems with object that are behind camera
- exploding at camera position - division by zero

Near and far plane clipping

- define near and far plane
- simple generalization

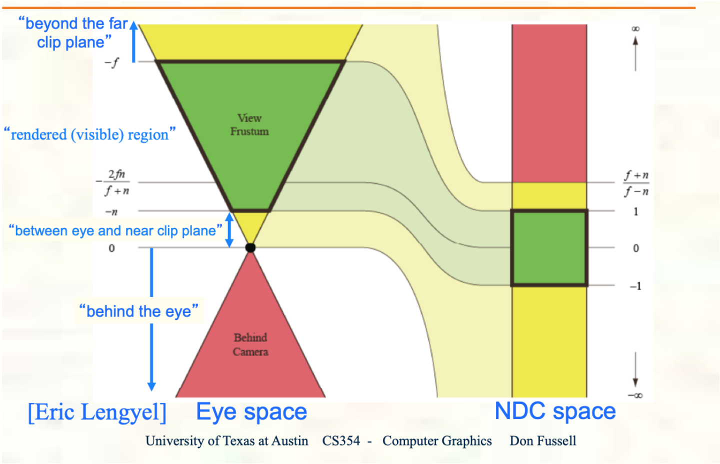
$$P = \begin{bmatrix} d & 0 & 0 & 0 \\ 0 & d & 0 & 0 \\ 0 & 0 & \alpha & \beta \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{2}$$

- we are looking for α, β that will map $z \rightarrow 1$ and $z \rightarrow -1$
-

$$P = \begin{bmatrix} n & 0 & 0 & 0 \\ 0 & n & 0 & 0 \\ 0 & 0 & \frac{f+n}{f-n} & -\frac{2fn}{f-n} \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{3}$$

- points outside $< -1, 1 >$ are clipped

Camera space



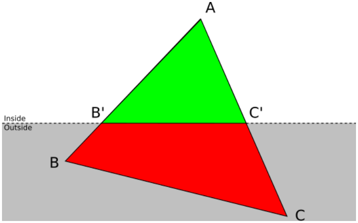
University of Texas at Austin CS354 - Computer Graphics Don Fussell

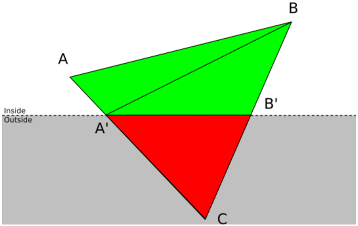
Field of view clipping

- $$\mathrm{P} = \begin{bmatrix} \frac{2n}{r-l} & 0 & 0 & 0 \\ 0 & \frac{2n}{t-b} & 0 & 0 \\ 0 & 0 & \frac{f+n}{f-n} & -\frac{2fn}{f-n} \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{4}$$
- x, y points outside $< -1, 1 >$ are clipped

Triangle clipping

- 3 vertices inside - accept
- 3 vertices outside -reject
- one vertex in front - subdivide
- two vertices in front - subdivide





Backface culling

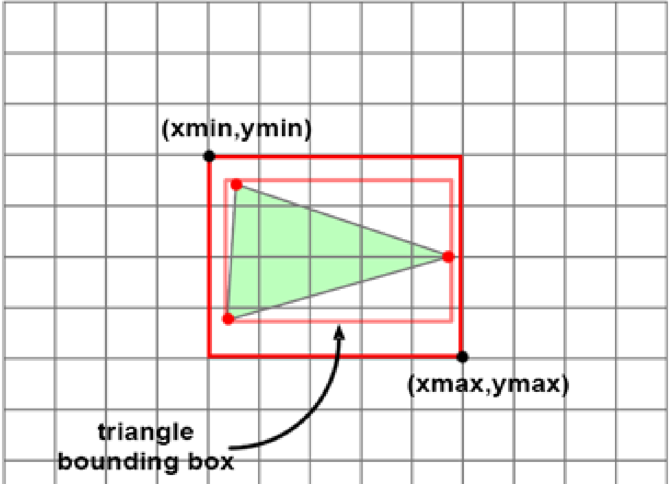
- triangle vertex order defies orientation
- surface normal: $V_1 V_2 \times V_2 V_3$
- normals pointing outside are not rendered

Hidden surface determination

- How to display object at different depth
- Some objects are hidden behind others
- pixel - object approach: raycasting
- object - pixel approach

Object centric approach

- assume all objects are triangles
- iterate over all triangles
- iterate over pixel of bounding box of triangle
- draw pixel contained within triangle



Z buffer

- store Z value for every pixel in Z buffer array
- start with infinite value
- if z value of new pixel is less that the corresponding value in buffer array, draw pixel and update buffer
- Perspective projection doesnt preserve distances:

$$\frac{1}{z_b} = \frac{\lambda_0}{V0_z} + \frac{\lambda_1}{V1_z} + \frac{\lambda_2}{V2_z} \tag{5}$$

- barycentric coordinates $\lambda_0 + \lambda_1 + \lambda_2$

Painter's algorithm

- find z depth for center of mass of every triangle
- order triangles
- draw them from farthest to nearest
- cons: cant handle intersections

Thank you!