CS174A Lecture 8

Announcements & Reminders

- *Midterm: Oct 29*
- *Midterm study guide posted in Piazza*
- *Team project proposals due: Oct 29*
- *Project #3 assigned in Piazza/Github*

TA Session This Friday

- ***Team project***
  - First draft of proposal due: 10/29/19
  - What's expected in the proposal
  - Still looking for teammates? Resolve this Friday
- ***Project assignment #3***
- ***Midterm review***

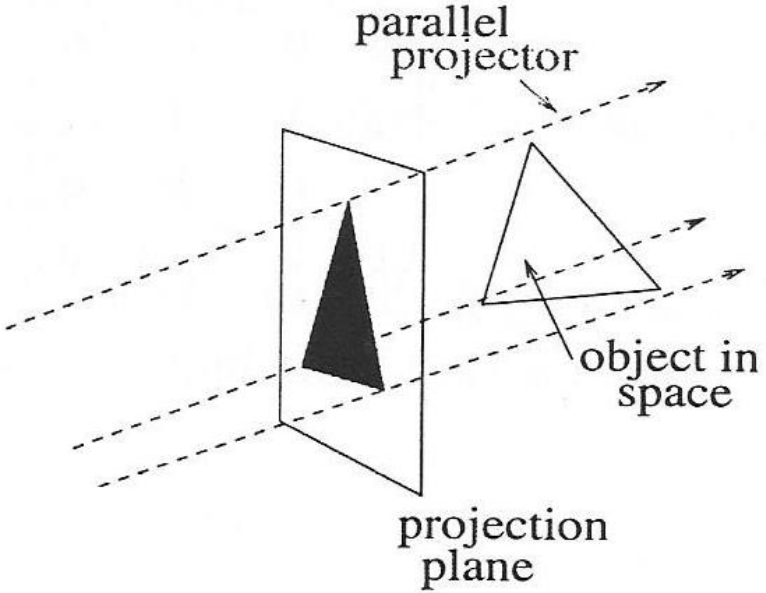
Last Lecture Recap

- ***Spaces:***
  - Model space
  - Object/world space
  - Eye/camera space
  - Screen space
- ***Projections: Parallel and Perspective***

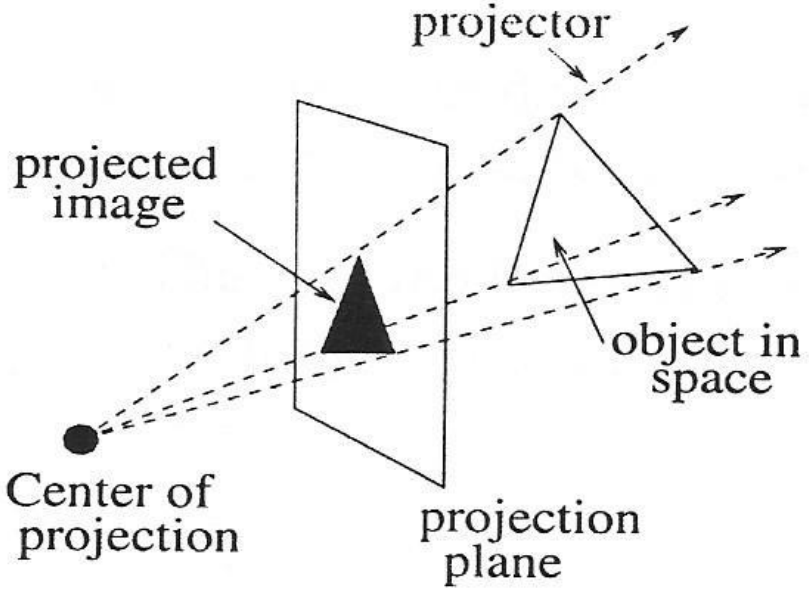
Next Up

- ***Projections: parallel and perspective***
  - Orthographic and perspective view volumes
  - Canonical (normalized) view volume
- ***Backface Culling***
- ***Hidden Surface Removal***
- ***Flat and Smooth Shading: introduction***
- ***Lighting***

Projections



Parallel projection



Perspective projection

Orthographic Projection

Orthographic PM = $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

View Volume

$-\frac{W}{2} <= X <= \frac{W}{2}$

$-\frac{H}{2} <= Y <= \frac{H}{2}$

$N <= Z <= F$

Normalized OPM = $\begin{bmatrix} \frac{2}{W} & 0 & 0 & 0 \\ 0 & \frac{2}{H} & 0 & 0 \\ 0 & 0 & \frac{1}{F-N} & -\frac{N}{F-N} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

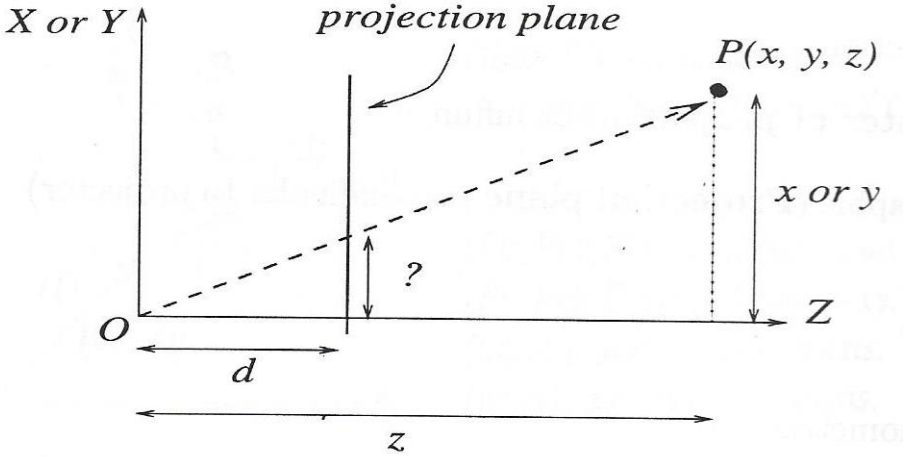
Canonical View Volume

$-1 <= X' <= 1$

$-1 <= Y' <= 1$

$0 <= Z' <= 1$

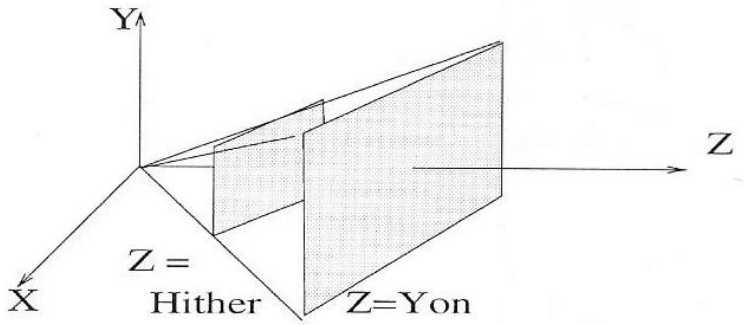
Perspective Projection

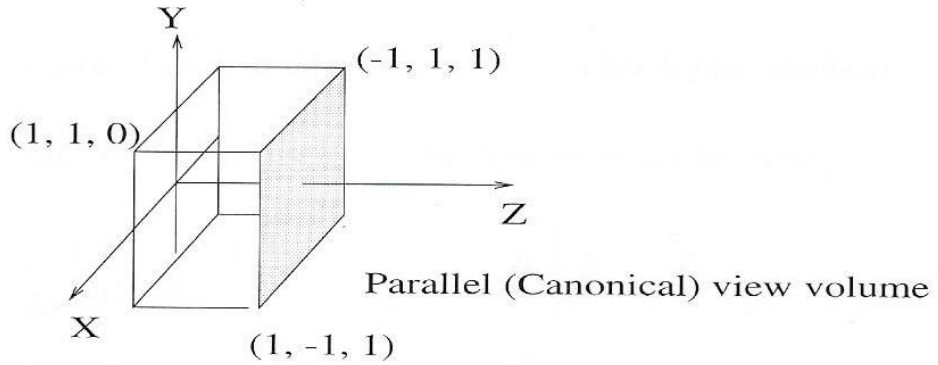


$$x \leftarrow \frac{x}{z}d; \quad y \leftarrow \frac{y}{z}d$$

Perspective PM (square viewport) = $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{d} & 0 \end{bmatrix}$

Perspective Projection





Aspect Ratio (A_r) = $\frac{W}{H}$

Half Angle of View = θ

Θ is defined wrt to x-axis

Normalized PPM = $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & A_r & 0 & 0 \\ 0 & 0 & Atan(\theta) & Btan(\theta) \\ 0 & 0 & \tan(\theta) & 0 \end{bmatrix}$

Perspective Projection

Normalized PPM = $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & A_r & 0 & 0 \\ 0 & 0 & Atan(\theta) & Btan(\theta) \\ 0 & 0 & \tan(\theta) & 0 \end{bmatrix}$

A = $\frac{F}{F-N}$

B = - $\frac{F*N}{F-N}$

Apply Perspective Division

How to handle –ve values of w? What does it mean?

As examples,

- Lower-bottom-near vertex of view volume (in eye space) with coordinates: (-N$tan(\theta)$, -N$tan(\theta)$/Ar, N) will map to (-1,-1,0) after pers div
- Upper-right-far vertex of view volume with coordinates: (F$tan(\theta)$, F$tan(\theta)$/Ar, F) will map to (1,1,1) after pers div

Window-to-Viewport Mapping

Change from normalized volume (xyz) to screen coordinates (XY)

xyz: normalized point after perspective division
XY: screen coordinates
v_l,v_b: lower-left corner of viewport
v_r,v_t: upper-right corner of viewport

$$X = x\frac{v_r - vl}{2} + \frac{v_r + vl}{2}$$
$$Y = y\frac{v_t - vb}{2} + \frac{v_t + vb}{2}$$