CS-174A Discussion 1C, Week 4

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@ Instructor: Dr. Asish Law

@ Discussion 1C Github: https://github.com/NoctisZ/CS174A-1C-2020Fall (https://github.com/NoctisZ/CS174A-1C-2020Fall)

Outline

- Announcements
- Recap of Lecture Content
- Q&A about Assignment 3
- Midterm Exercises

Announcements

Assginments

- Due date of Assignment 3 moved to 11/15, Sunday
- Due date changes of following assignment/project proposal
- Check new syllabus for more information: https://ccle.ucla.edu/local/ucla_syllabus/index.php?id=90888 (https://ccle.ucla.edu/local/ucla_syllabus/index.php?id=90888)

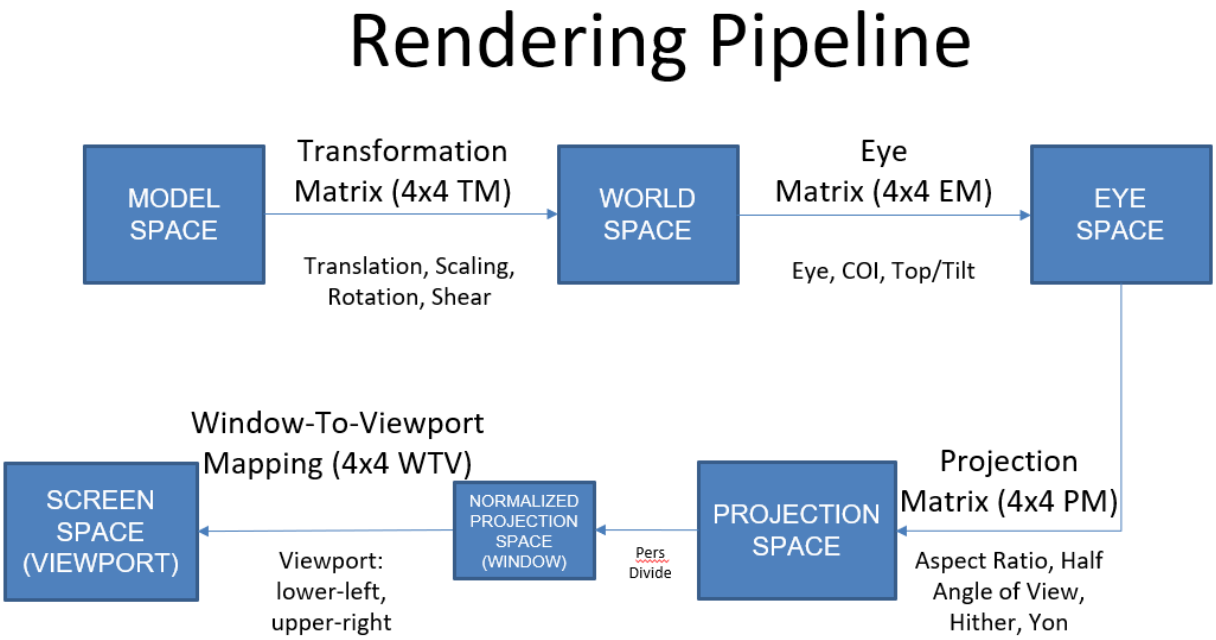
Midterm

- Midterm will be on 11/5, 7:00 - 8:30 PM, in our regular class Zoom meeting
- Check online midterm instruction for more details: https://ccle.ucla.edu/pluginfile.php/3801882/mod_resource/content/0/CS174A%20Online%20Midte (https://ccle.ucla.edu/pluginfile.php/3801882/mod_resource/content/0/CS174A%20Online%20Midt
- Midterm study guide: https://ccle.ucla.edu/pluginfile.php/3838436/mod_resource/content/0/CS174A%20Study%20Guide%20Midterm.pdf (https://ccle.ucla.edu/pluginfile.php/3838436/mod_resource/content/0/CS174A%20Study%20Guide%20Midterm.pdf)

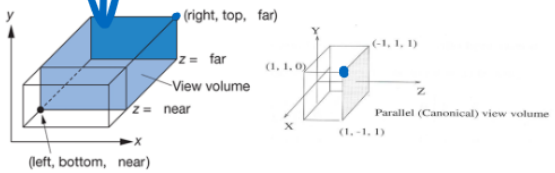
Team Project Proposal

- When submit your team project proposal (due on 11/17), make sure to submit the **Google form** to record your team members: https://docs.google.com/forms/u/2/d/e/1FAIpQLSfIQsZIF-kuQziq3NiGYac4qZvaSZ0hRzfLLdVd-bdUrfGz-A/viewform?usp=send_form (https://docs.google.com/forms/u/2/d/e/1FAIpQLSfIQsZIF-kuQziq3NiGYac4qZvaSZ0hRzfLLdVd-bdUrfGz-A/viewform?usp=send_form)

Review of Lecture Content



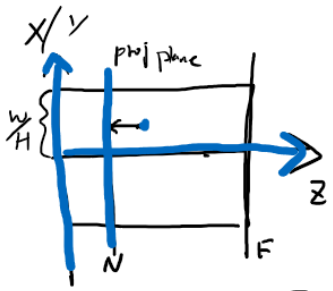
Parallel Projection



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

View Volume

$$-\frac{W}{2} <= X <= \frac{W}{2}$$
$$-\frac{H}{2} <= Y <= \frac{H}{2}$$
$$N <= Z <= F$$



$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Parallel Projection

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

View Volume

$$-\frac{W}{2} <= X <= \frac{W}{2}$$
$$-\frac{H}{2} <= Y <= \frac{H}{2}$$
$$N <= Z <= F$$

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

Canonical View Volume

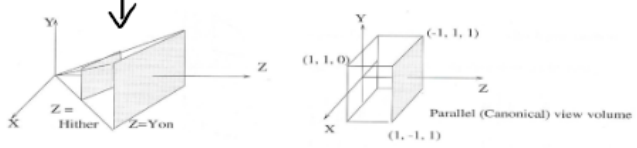
$$-1 <= X' <= 1$$
$$-1 <= Y' <= 1$$
$$0 <= Z' <= 1$$

Screenshot(Alt + A)

$$= \begin{bmatrix} \frac{2}{W} & 0 & 0 & 0 \\ 0 & \frac{2}{H} & 0 & 0 \\ 0 & 0 & \frac{1}{F-N} & \frac{N}{F-N} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \begin{bmatrix} W \\ H \\ 2 \\ F \\ 1 \end{bmatrix}$$

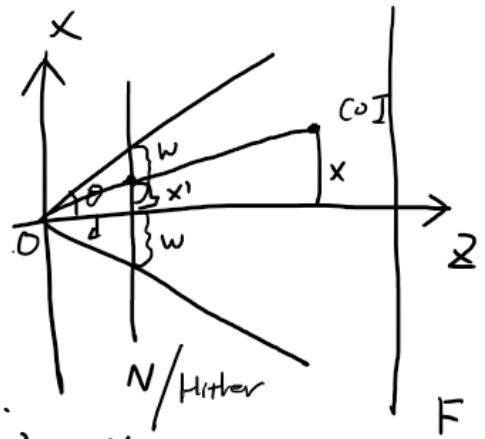
$$= \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

Perspective Projection



Aspect Ratio (A_r) = $\frac{W}{H}$
Half Angle of View = θ
Θ is defined wrt to x-axis

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



Perspective Projection

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

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

Apply Perspective Division
How to handle -ve values of w? What does it mean?

As examples,

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

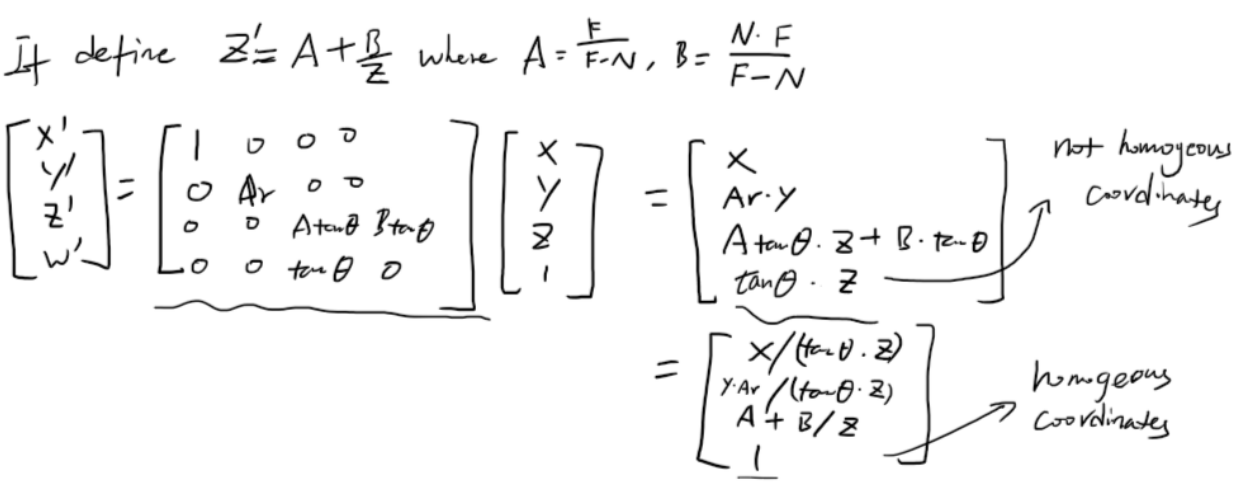
$$\frac{x'}{d} = \frac{x}{z} \qquad \frac{y'}{d} = \frac{y}{z}$$

$$\Rightarrow x' = \frac{x}{z}\frac{d}{w} \qquad y' = \frac{y}{z}\frac{d}{H}$$

$$\tan\theta = \frac{w}{d} \qquad A_r = \frac{W}{H}$$

$$\tan\theta = \frac{d}{w}$$

$$x' = \frac{x}{z\tan\theta} \qquad y' = \frac{y \cdot A_r}{z \cdot \tan\theta}$$



Q&A about Assignment 3

- Placement of sun and lighting
- Placement of planets
- Set up the camera

Exercises for Midterm

2.11 In practice, testing each point in a polygon to determine whether it is inside or outside the polygon is extremely inefficient. Describe the general strategies that you might pursue to avoid point-by-point testing.

Answer to 2.11:
We can use a line-by-line approach using scanlines, which corresponds to a row of pixels in framebuffers:

- look at the intersections of the polygon edges with scanlines, and order those intersections
- 1st intersection begins a set of points inside the polygon, 2nd leaves the polygon, etc.

4.1 Show that the following sequences commute:

a. a rotation and a uniform scaling

b. two rotations about the same axis

c. two translations

Q: Briefly describe what changes you would expect to see in the image with respect to the following changes in viewing parameters, all other params remaining unchanged:

- Half-angle-of-view decreases
- Aspect ratio increases
- COI moves closer to eye point

- Eye point moves away from COI
- Top vector becomes upside down
- Distance between hither (near plane) and yon increases

Answers:

- Half-angle-of-view decreases: objects will project larger on window and viewport, because camera is now capturing lesser volume of the scene while image size remains same
- Aspect ratio increases: AR increases implies viewport became wider or the height decreased; if angle did not change then some objects may be clipped off; the final image will definitely look wider
- COI moves closer to eye point: no change in image
- Eye point moves away from COI: a different image will be grabbed because the location of eye changed
- Top vector becomes upside down: image will turn upside down
- Distance between hither and yon increases: depending on which direction H and Y moves, more or less objects will be included in the view volume