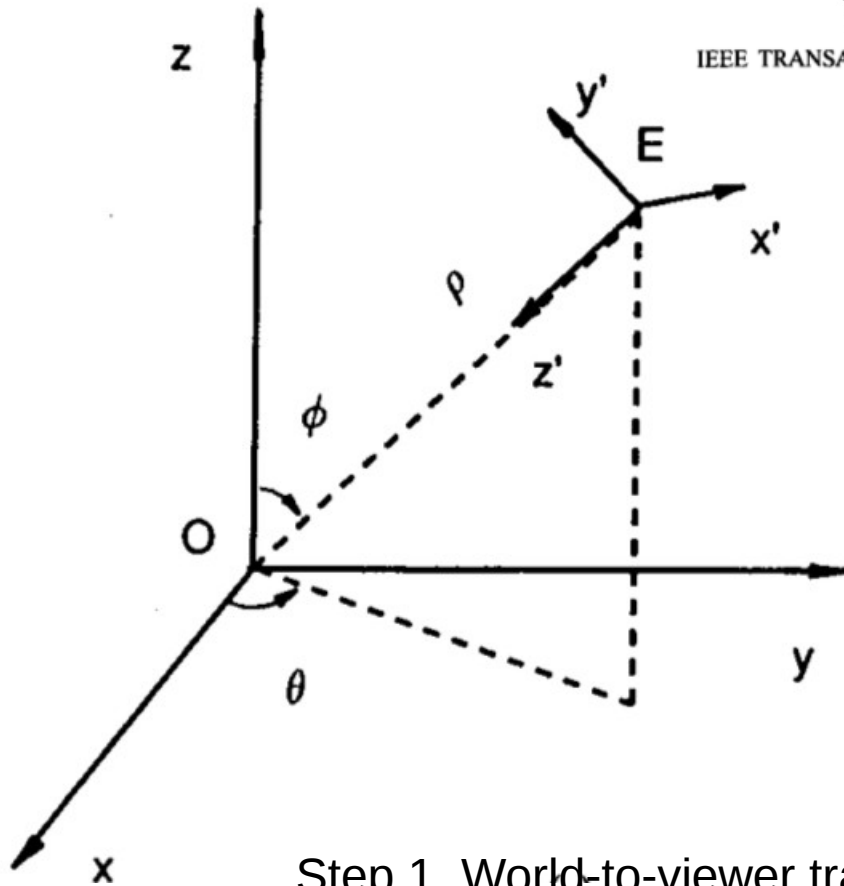


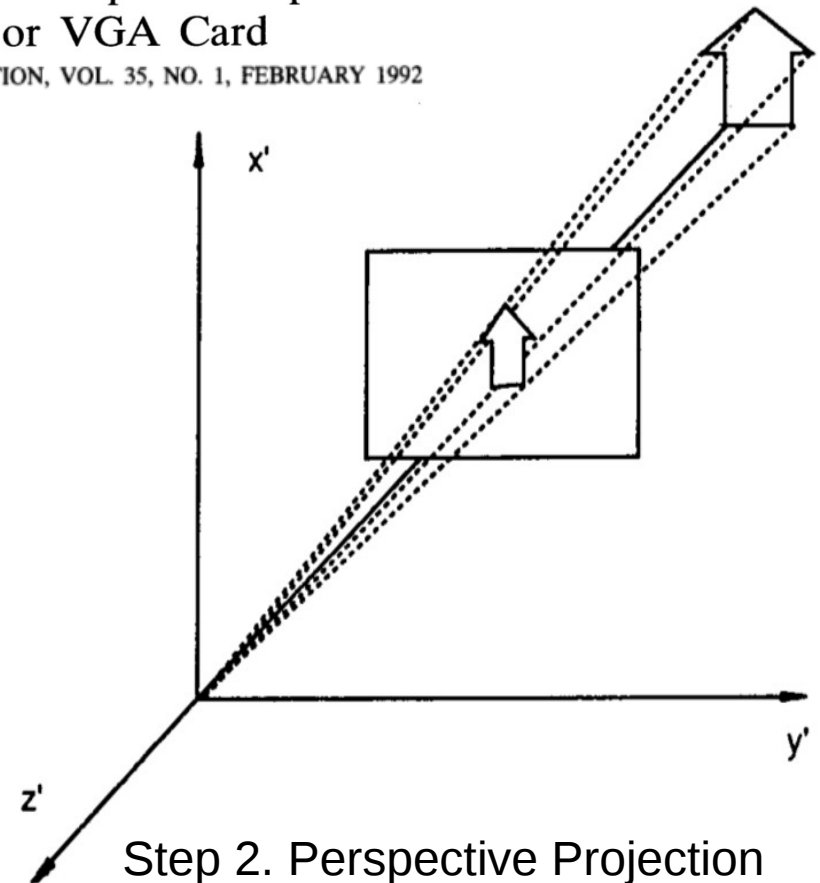
3D Transformation Pipeline Technique

Reference: H. Li Three-Dimensional Computer Graphics
Using EGA or VGA Card

IEEE TRANSACTIONS ON EDUCATION, VOL. 35, NO. 1, FEBRUARY 1992



Step 1. World-to-viewer transform



Step 2. Perspective Projection

$$\mathbf{T} = \begin{bmatrix} -\sin \theta & \cos \theta & 0 & 0 \\ -\cos \phi \cos \theta & -\cos \phi \sin \theta & \sin \phi & 0 \\ -\sin \phi \cos \theta & -\sin \phi \sin \theta & -\cos \phi & \rho \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$x_p = x_e \left(\frac{D}{z_e} \right)$$

$$y_p = y_e \left(\frac{D}{z_e} \right)$$

10-10-2018 Transformation Pipeline

CMPE240 Adv. Microprocessor Systems Oct. 10th, 2018 Harry Li

1. 3D G.E. (Graphics Engine) Design. World-2-Viewer Transform.

Eqn (1) from the P.P.T.

Example:

World-Coordinate System.

Virtual Cam Location $\vec{E}(x_e, y_e, z_e)$
 z_e -axis: Towards $O(0,0,0)$ OpenGL
 "Viewer" Coordinate System. 3D
 "Left Hand"

θ : ON x_w - y_w plane Counter-CLKwise \pm
 ϕ : ON a triangle formed by \vec{E} , \vec{O} and line passing \vec{E} , perpendicular to z_w .

R.H.

After P_i (Viewer)

Before P_i (World)

Example: Step 1. Design Data Set

$\{ \vec{P}_i(x_i, y_i, z_i) | i=0,1,\dots,7 \}$ Side=100

$\vec{P}_0(0,100,0)$ $\vec{P}_1(0,100,100)$ $\vec{P}_2(100,100,100)$
 $\vec{P}_3(100,100,0)$ and so on.

$S_0: \vec{P}_1 - \vec{P}_4 - \vec{P}_5(100,0,100) - \vec{P}_2$

10-10-2018 World-to-Viewer Transform

From Eqn (4): $\rho = \sqrt{x_e^2 + y_e^2 + z_e^2}$

$$\begin{bmatrix} - \\ - \\ - \end{bmatrix} \begin{bmatrix} s & c \\ c & s \\ c & c \end{bmatrix} \begin{bmatrix} c & c & s & \rho \\ s & s & c & \rho \end{bmatrix}$$

θ ϕ

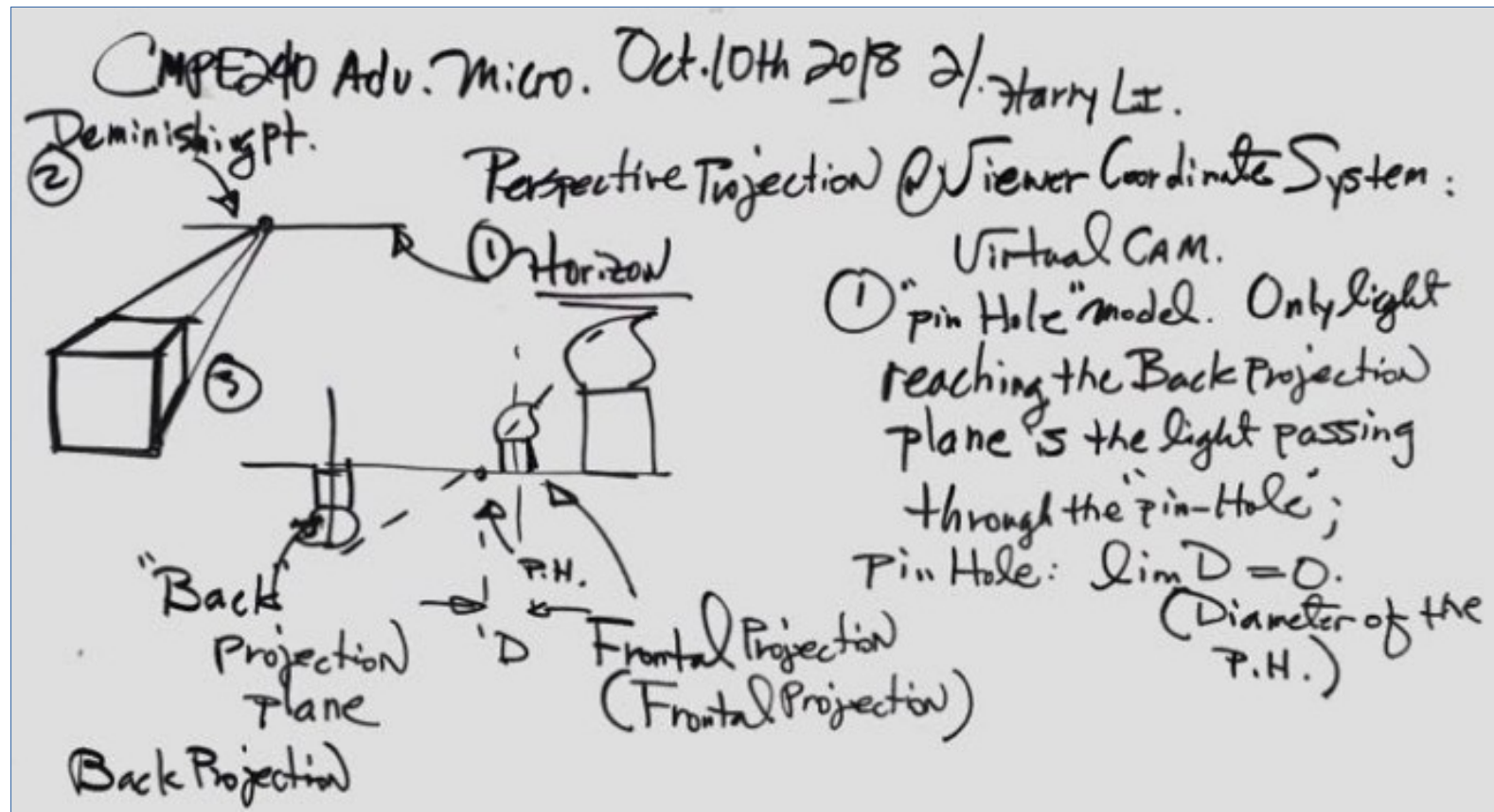
$$\sin \theta = \frac{y_e}{\sqrt{x_e^2 + y_e^2}} = \frac{200}{\sqrt{200^2 + 200^2}} = \frac{\sqrt{2}}{2}, \quad \cos \theta = \frac{x_e}{\sqrt{x_e^2 + y_e^2}} = \frac{\sqrt{2}}{2}$$

$$\sin \phi = \frac{\sqrt{x_e^2 + y_e^2}}{\sqrt{x_e^2 + y_e^2 + z_e^2}} = \frac{200\sqrt{2}}{200\sqrt{3}} = \frac{\sqrt{6}}{3}$$

$$\cos \phi = \frac{z_e}{\sqrt{x_e^2 + y_e^2 + z_e^2}} = \frac{200}{200\sqrt{3}} = \frac{\sqrt{3}}{3}, \quad \rho = 200\sqrt{3}$$

$$\begin{cases} X_{\text{prim}}[i] = -S_{\theta} \cos \phi * x[i] + C_{\theta} \cos \phi * y[i]; \\ Y_{\text{prim}}[i] = -C_{\theta} \cos \phi * x[i] - S_{\theta} \cos \phi * y[i] + \\ \quad S_{\phi} * z[i]; \\ Z_{\text{prim}}[i] = -C_{\theta} \sin \phi * x[i] - \\ \quad C_{\theta} \sin \phi * y[i] - C_{\phi} * z[i] + r_{ho}; \end{cases}$$

10-10-2018 Perspective Projection



10-15-2018 Perspective Projection

CMPE240 Adv. Microprocessor Systems Oct. 15th, 2018 Harry Li

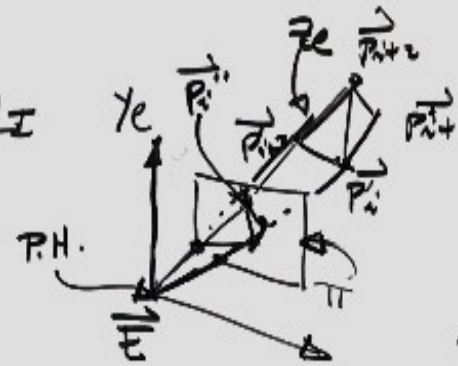
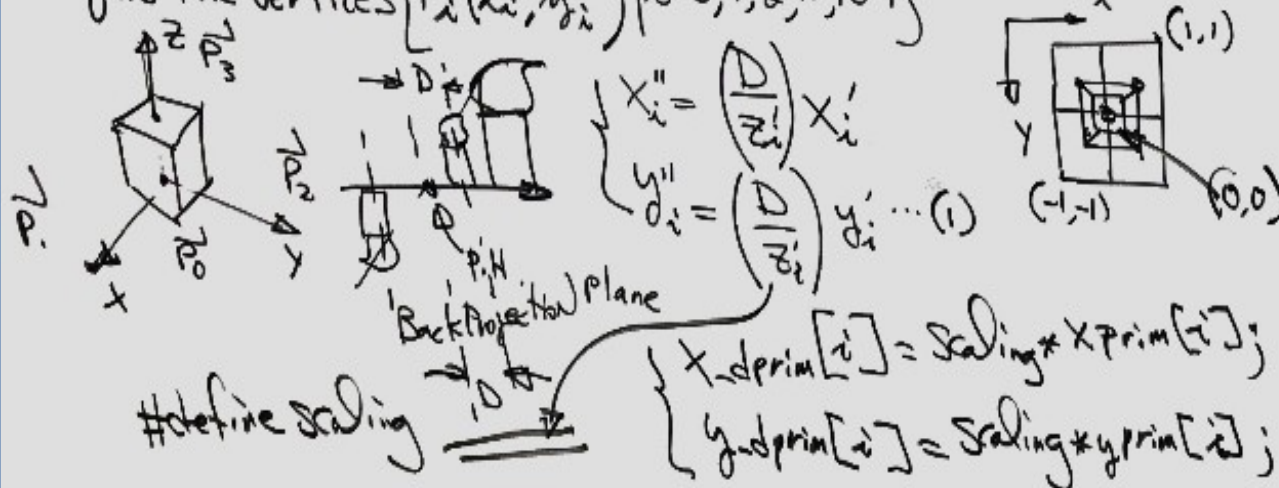
Today's Topics:

1° Perspective Projection

Example: Given,

$\{P_i'(x_i', y_i', z_i') | i=0, 1, 2, \dots, N-1\}$ IN Viewer Coordinate System.

find the vertices $\{P_i''(x_i'', y_i'') | i=0, 1, 2, \dots, N-1\}$



Similarly, for y-comp.

$$\frac{D}{z_i'} = \frac{y_i''}{y_i'}, \text{ hence, we have Eqn (1)}$$

Next framework

Example: Step 1 Design $\{P_i(x_i, y_i, z_i) | i=0, 1, 2, 3\}$
 $P_0(0,0,0), P_1(50,0,0), P_2(0,50,0), P_3(0,0,50)$

Step 2. Define $E(x_e, y_e, z_e) = (6, 6, 60)$

Step 3. $\cos\theta, \sin\theta, \cos\phi, \sin\phi$ who

Step 4. 3-lines of C/C++ Code for
 World-2-Viewer Transform;