A TRIP DOWN THE GRAPHICS PIPELINE

How to get from the world to your screen

From: Tip of thumb - 1 inch from the knuckle, down y-axis
- knuckle co-ordinate system

To: Position in NDC ⇒ normalized device coordinates
↑ What happens then? something colors the pixels
scan conversion

Local Co-Ords

Rigid Skeleton

ThumbTip 0, -1, 0 in Knuckle
Knuckle → Thumb

Rotate ⊖
Translate ↕

Thumb → Hand
Rotate
Translate
Hand → Elbow
R
T
Elbow → Shoulder
⋮

Body

thumbtip in wrist
thumbtip in thumb co-ords

TR ... TR TR TR $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$

thumbtip in Body

thumbtip in ⌐

ThumbTip

will need for other parts of body

Stack

Code: translate
rotate
trans
rot
.....
vertex — An aside, what to do with vertex?

pushes / pops

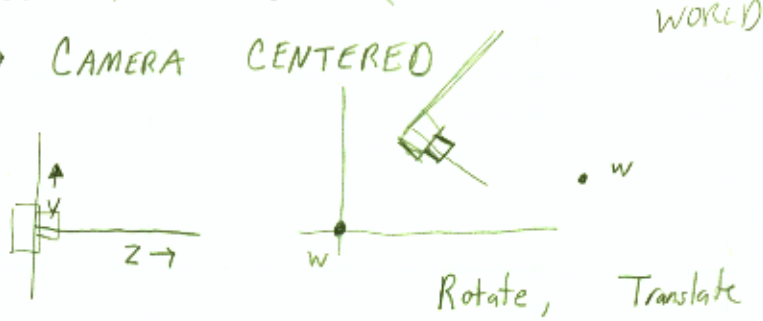
gl: Begin / END
- POINTS
- LINES
- LINESTRIP — LOOP
- POLY — TRIANGLES
- TRI-STRIP
- QUADSTRIP

Point Sharing: efficiency

BACK TO OUR STORY

BODY → WORLD ← MODELING TRANSFORM
WORLD

WORLD → CAMERA CENTERED



Rotate, Translate

GL, camera sights down -z

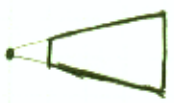
camera ← T R ← world

or gluLookat command ← VIEWING TRANSFORM

CAMERA CENTERED → SCREEN

Projection

Frustrum



gluFrustum
gluPerspective

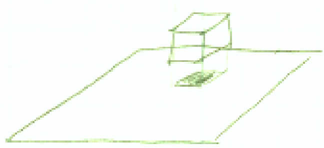
$(x, y, z) = h \; \{ \; P \; \} \; V \; \} \cdots\cdots T \, R \, T \, R \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$

- (x, y, z): need to know how far away
- h: divide by w
- Clip or Frustum
- Camera
- WORLD

VIEWPORT (where on screen)
ASPECT RATIO

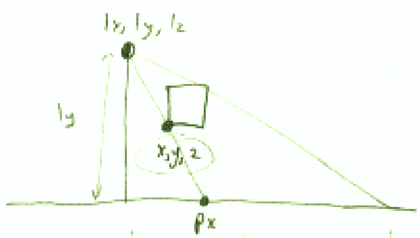
Clipping

An Application = Shadows



drop shadows, squish y=0 to floor

Point Source Shadows



eye @ light source
film @ surface

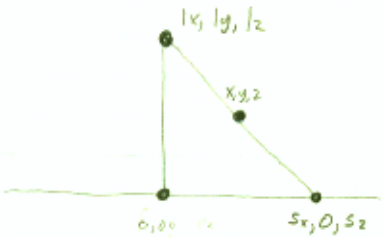
$$\frac{p_x - l_x}{p_y - l_y} = \frac{x - l_x}{y - l_y}$$

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

$$p_x - l_x = (p_y - l_y) \, \frac{x - l_x}{y - l_y} + l_x$$

(p_y → 0)

$$-l_y \, \frac{(x - l_x)}{(y - l_y)} + \frac{l_x \, (y - l_y)}{(y - l_y)}$$



$$\frac{x - lx}{y - ly} = \frac{sx - lx}{0 - ly}$$

$$* -ly \Rightarrow \quad sx - lx = -ly\left(\frac{x - lx}{y - ly}\right)$$

$$+lx \Rightarrow \quad sx = \frac{-ly\,x + lx\,ly}{y - ly} + \frac{(y - ly)\ lx}{(y - ly)}$$

$lx, ly, lz = 0, 4, 0 \qquad 1, 4$
$x, y, z = 2, 2$

$$= \frac{-ly\,x}{y - ly} + \frac{lx\,ly + y\,lx - lx\,ly}{y - ly}$$

$$sx = \frac{ly\,x}{ly - y} + \frac{-y\,lx}{ly - y}$$

$$\frac{8}{2} + \frac{0}{2}$$

$$\frac{8}{2} + \frac{-2}{2}$$

do this first → 2nd →

$$\begin{bmatrix} ly & -lx & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & -lz & ly & 0 \\ 0 & -1 & 0 & ly \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$