Homogeneous transformations

Graphics pipelines

input

$$\Rightarrow \square \Rightarrow [\ ] \Rightarrow [\ ] \Rightarrow$$ raster

pixel
pictur element
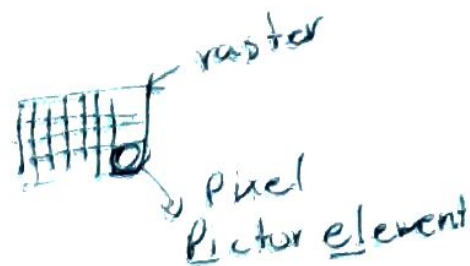
- color
- light
- vectos/ normals
- geometrical info

Transformations
- scale
- rotate
- translation

image
- restolution: 70 dpi
- dimension: H y W
- ratio: 16:9 (expect ratio)

3D model

set of 3D points, edges, faces

To <u>simplify</u> transformators.
we use Homogeneous space/ transformations

$$3D \text{ space} \longrightarrow H \text{ 3D space}$$
$$(x,y,z) \longrightarrow (x,y,z,1)$$
$$\left(\frac{x}{w}, \frac{y}{w}, \frac{z}{w}\right) \longleftarrow (x,y,z,w)$$
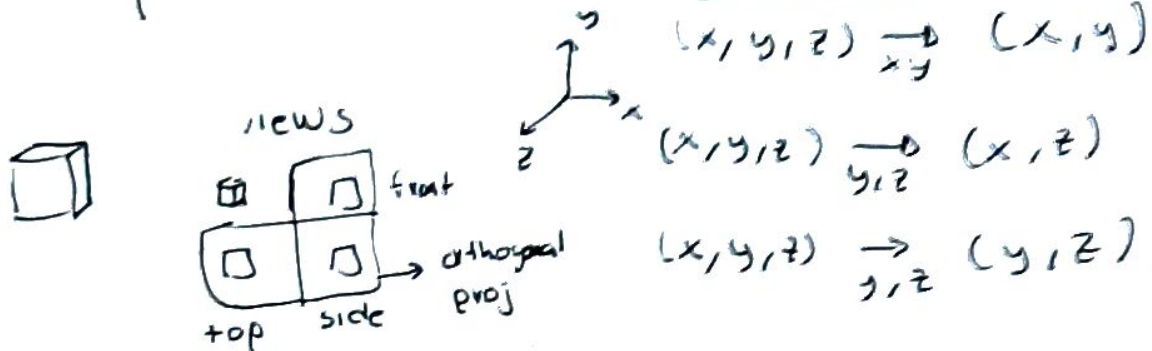
Scale

$$\begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & S_z \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} S_x \cdot x \\ S_y \cdot y \\ S_z \cdot z \end{bmatrix}$$

translation

$$\begin{bmatrix} 1 & 0 & 0 & t_x \\ 0 & 1 & 0 & t_y \\ 0 & 0 & 1 & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x + t_x \\ y + t_y \\ z + t_z \\ 1 \end{bmatrix}$$

Changes in perspective

Medium { — 2D) surface

orthogonal!

$(x, y, z) \xrightarrow[x \cdot y]{} (x, y)$

$(x, y, z) \xrightarrow[y, z]{} (x, z)$

$(x, y, z) \xrightarrow[y, z]{} (y, z)$

views

front

orthogonal proj

top   side

Perspective projection

pinhole camera

Center Projection   plane projection   3D obj

→ intersection (Usp and ray)

| 3D | | 2D |

$P(x, y, z) \xRightarrow{f} \left(\dfrac{x \cdot f}{z}, \dfrac{y \cdot f}{z} \right)$
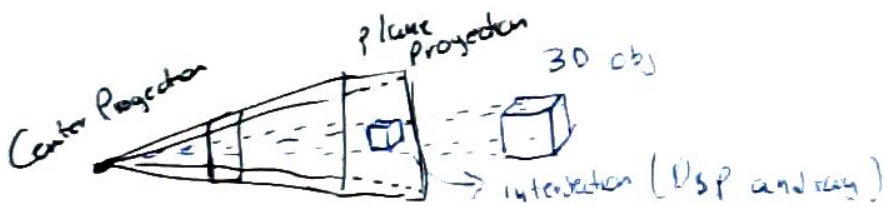
Matrix Proj P $P'H$ $P'3D$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \frac{1}{f} & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \\ \frac{z}{f} \end{bmatrix} \Bigg\} w \Rightarrow \begin{bmatrix} \frac{x \cdot f}{z} \\ \frac{y \cdot f}{z} \\ f \\ 1 \end{bmatrix}$$

Graphic primitives (operations)

Lights

Camera

3D object

graphics engine → photorealistic
↘ Simulation
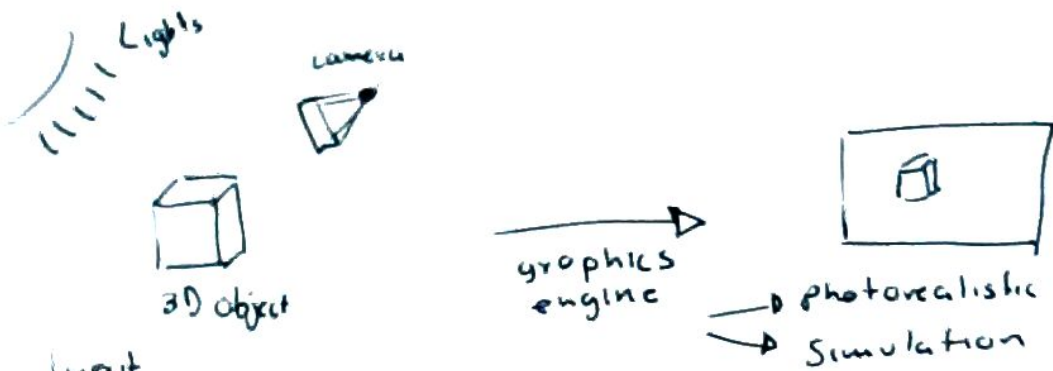
Input
- 3D obj
- lights
- material
- Camera
- Textures
- shaders
- extra

H S V
↓ ↓ ↘ value
Hue Saturation