

Homework 6A Solution

- 1) Given the 3D cube example in programs: ortho.js and ortho.html (available on the course web page), if the view position and the orthographic viewing volume is change into each of the following situations, how will the final 2D image change from its original image?

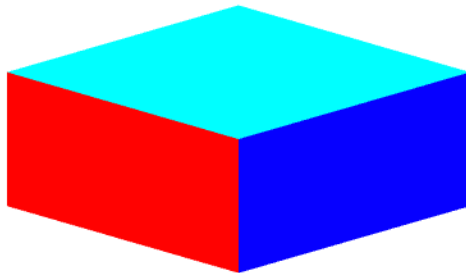
- a. `mvMatrix=lookAt(vec3(-4, 0, 0), at, up);` // pMatrix does not change
`pMatrix = ortho(-2, 2, -4, 4, 0, 10);` // given

Shows the yellow rectangle, the left face of the cube, because the eye is now to the left of the cube looking to the center of the cube. The viewing volume is twice as tall (bottom=-4, top=4) as it is wide (left= -2, right=2). The height of the cube is $\frac{1}{4}$ of the original height, and the width of the cube is $\frac{1}{2}$ of the original width. The left side of the cube is displayed as a rectangle with width to height ratio of 2:1.



- b. `mvMatrix=lookAt(vec3(3, 3, 3), at, up);` // pMatrix does not change
`pMatrix = ortho(-2, 2, -4, 4, 0, 10);` // given

Shows the top, right, and front faces of the cube, because the eye is at point (3, 3, 3) looking into the origin. Only the that corner of the cube is observed. Still the cube is shown half as tall as it is width and depth, due to the ratio between the viewing volume height (8 along y-axis) and width (4 along x-axis).



- c. `mvMatrix=lookAt(vec3(3, 3, 3), at, up);`
`pMatrix=ortho(-3, 3, -3, 3, -1, 1);`

No display, because the cube is outside of the viewing volume

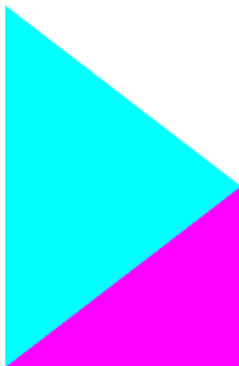
- d. `pMatrix= ortho(-6, 6, -3, 3, 2, 10); // mvMatrix does not change`
`var eye = vec3(4, 4, -4); // given`

The entire cube is now inside the viewing volume, between near plane (-2) and far plane (-10). It appears taller than its width. The width of the view volume is doubled and the height of the view volume does not change. Therefore, the height of the cube looks twice as tall as it is wide. The eye is looking down at the cube from behind, upper right. The top, back and right sides are shown.



- e. `pMatrix=ortho(0, 4, 0, 3, 2, 10); // mvMatrix does not change`
`var eye = vec3(4, 4, -4); // given`

Only $\frac{1}{4}$ of the cube (the upper, right $\frac{1}{4}$) is inside the view volume and displayed. Therefore only partial top and back side is viewable. The width and height ratio of the displayed portion is 3:4 corresponding to the width and height ratio of the viewing volume.



- 2) Given: $\text{mvMatrix}=\text{lookAt}(\text{vec3}(4, 4, -4), \text{at}, \text{up});$
 $\text{pMatrix}=\text{ortho}(-2, 2, -4, 4, -10, 10);$
show:
• the mvMatrix

$\text{n}=\text{eye}-\text{look}=[4, 4, -4]$

normalized n: $[0.577, 0.577, -0.577]$

$\text{u}=\text{up} \times \text{n} = [0, 1, 0] \times [0.577, 0.577, -0.577]$

normalized u: $[-0.707, 0, -0.707]$

$\text{v}=\text{n} \times \text{u} = [0.577, 0.577, -0.577] \times [-0.707, 0, -0.707]$

normalized v: $[-0.408, 0.816, 0.408]$

$-\text{dot}(\text{u}, \text{eye}) = 0$

$-\text{dot}(\text{v}, \text{eye}) = 0$

$-\text{dot}(\text{n}, \text{eye}) = -6.928$

$$\text{view matrix} = \begin{bmatrix} -0.707 & 0 & -0.707 & 0 \\ -0.408 & 0.816 & 0.408 & 0 \\ 0.577 & 0.577 & -0.577 & -6.928 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$