TUTORIAL 7 - EXERCISES

MATRIX RELOADED 2 - VIEWING TRANSFORMATIONS

PART 1: THEORY

EXERCISE 1

(a) What is the viewport transformation? Which parameters characterize it?
(b) What is the orthographic transformation? Which parameters characterize it?
(c) In which order do we apply the transformations for the "graphics pipeline"?
(d) Why are some of the transformations described by two matrices concatenated?
(e) Why can't projective transformations be achieved using affine transformations?
(f) Argue that projective transformations are a more general form of affine transformations.
(g) Are transformations in the "graphics pipeline" active or passive transformations?
(h) What is the canonical view volume?

PART 2: TRANSFORMATIONS

EXERCISE 2

The following matrix M_{orth} maps the orthographic view volume to the canonical view volume:

$$M_{orth} = \begin{bmatrix} \frac{2}{r-l} & 0 & 0 & \frac{l+r}{l-r} \\ 0 & \frac{2}{t-b} & 0 & \frac{b+t}{b-t} \\ 0 & 0 & \frac{2}{n-f} & \frac{n+f}{f-n} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(a) How is the orthographic view volume defined?
(b) How is the canonical view volume defined?
(c) Where does this transformation map the corners of the orthographic view volume to?
(d) What is the matrix M_{vp} for a screen of size $L_x \times L_y$?
(e) Compute the concatenation $M_{vp}M_{orth}$. Which space does it map to? From which space?

EXERCISE 3

Given an eye in position $e = (3,4,2)$, a gaze vector $\vec{g} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$ and a view-up vector $\vec{t} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

(a) Compute the gaze direction $\hat{g}$.
(b) Write the co-ordinate system given by this information.
(c) Write the rotation matrix needed to map to that co-ordinate system.
(d) Write the translation matrix needed to map to that co-ordinate system from the (x, y, z) co-ordinate system.
(e) Concatenate the two matrices. What do we obtain? Which space does it map to? From which space?

EXERCISE 4

Consider the projection transformation, with the eye gazing into the $-z$ direction. The near plane is at $z = n$ while the far plane is at $z = f$.

(a) Where does it map x and y for a point to?
(b) Where does it map z for a point to? Can it map any value of z?
(c) What is the projection matrix P? Is it an affine transformation?
(d) Apply P to a generic vector $\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$. What is the meaning of the last coordinate of the vector?
(e) Write the result of (d) in the extended co-ordinate space (i.e. with the usual extended vector).