**CSCI 4250/5250 Homework 5 (Due beginning of class, Tuesday Oct 31st)**

***You are required to type your answers. Submit to the D2L Dropbox labeled “homework 5”***

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 changed into each of the following situations, how will the final 2D image change from its original image? Justify your answer.
   * 1. mvMatrix=lookAt(vec3(-4, 0, 0), at, up); // pMatrix does not change

It becomes just a yellow rectangle, The lookAt function is only changing the eye position to -4 on the X-axis. This positions the eye looking only at the AECG plane which is colored yellow. Since the eye is also positioned at 0 on the Y and Z axis this yellow square is formed into a rectangle

* + 1. mvMatrix=lookAt(vec3(3, 3, 3), at, up); // pMatrix does not change

You can view the complete cyan top of the object (plane AEFB), and half of the blue side (plane BFDH) and half of the magenta side (plane EFGH). Again only the eye is changed in the lookAt function moving the eye to 3, 3, 3 on the X, Y , Z Axis respectfully. This position of the eye is on the opposite Z axis of the original giving us the ability to view the blue and magenta sides, and is positioned slightly closer on the X and Y axis.

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

You are unable to view the object anymore as the ortho function near and far variables are set far too close for the drawn object. It is drawn outside of the viewing plane.

* + 1. pMatrix= ortho(-6, 6, -3, 3, 2, 10); // mvMatrix does not change

You can view the cyan top (plane EFAB) and the blue and magenta sides, however the sides are now elongated because the ortho function’s X axis parameters -6, 6 makes the viewing plane much larger in the horizontal direction. This causes the sides to be longer and skinner when they are scaled to the new viewing plane.

* + 1. pMatrix=ortho(0, 4, 0, 3, 2, 10); // mvMatrix does not change

You can only see the corner of the top cyan side (plane EFAB) and the top right corner of the magenta side (plane EFGH). This is because in this ortho function the X and Y axis do not go in the negatives for their respective axis. This causes for a much more zoomed in perspective of the object with a majority of it drawn off the canvas as those points are outside of the designated viewing plane.

1. Given: mvMatrix=lookAt(vec3(4, 4, - 4), at, up); pMatrix=ortho(-2, 2, -4, 4, -10, 10); show:

n= eye – look = (4,4,-4) –(0,0,0) = (4,4,-4)

u= up x n = (-4,0,-4)

v = n x u = (-16, -32, 16)

|n| about = 6.928

|u| about = 5.657

|v| about = 39.192

Normalized n = n / |n| about = (0.577, 0.577, -0.577)

Normalized u = u / |u| about = (-0.707, 0 , -0.707)

Normalized v = v / |v| about = ( -0.408, 0.816, 0.408)

dx = u . eye = 0

dy= v . eye = 0

dz = n . eye about = -6.928

• the mvMatrix

|  |  |  |  |
| --- | --- | --- | --- |
| -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 |

* + the pMatrix

|  |  |  |  |
| --- | --- | --- | --- |
| 2 /  (2 –(-2) ) | 0 | 0 | 0 |
| 0 | 2 / ( 4 – (-4)) | 0 | 0 |
| 0 | 0 | -2 / (10 – (-10) ) | 0 |
| 0 | 0 | 0 | 1 |

\*

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 0 | 0 | * ( -2 +2) / 2 |
| 0 | 1 | 0 | * (-4 +4 ) / 2 |
| 0 | 0 | 1 | (-10 +10) /2 |
| 0 | 0 | 0 | 1 |

=

|  |  |  |  |
| --- | --- | --- | --- |
| ½ | 0 | 0 | 0 |
| 0 | ¼ | 0 | 0 |
| 0 | 0 | * 1/10 | 0 |
| 0 | 0 | 0 | 1 |

* + the coordinates of a point F(1, 1, -1) when converted into the final clip coordinates.

(show intermediate steps in deriving the results)

PV =

|  |  |  |  |
| --- | --- | --- | --- |
| ½ | 0 | 0 | 0 |
| 0 | ¼ | 0 | 0 |
| 0 | 0 | * 1/10 | 0 |
| 0 | 0 | 0 | 1 |

\*

|  |  |  |  |
| --- | --- | --- | --- |
| -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 |

=

|  |  |  |  |
| --- | --- | --- | --- |
| -0.3535 | 0 | -0.3535 | 0 |
| -0.102 | 0.204 | 0.102 | 0 |
| -0.0577 | -0.0577 | 0.0577 | 0.6928 |
| 0 | 0 | 0 | 1 |

PV \* F(1, 1, -1) = (0, 0, 0.5197, 1) = New position of F

1. Changing the orthographic viewing volume in problem 2) to a frustum with left=-2, right=2, bottom=-4, top=4 for the near plane, and the near plane at distance 4 and far plane at distance 10 from the eye/camera. How would you call the perspective function to set up the corresponding pMatrix in the .js program?

Aspect = (2 – (-2)) / (4 – (-4) ) ;

viewAngle = 2 \* arctan ( ½ \* (4 – (-4)) / 4 ) ;

perspective(viewAngle, Aspect, 4, 10);

1. With the perspective viewing volume defined in problem 3), what will be the x and y coordinates of the two points F(1, 1, -1) and B(1, 1, 1) when projected onto the near plane?

P\*x = NPx / - Pz

P\*y = NPy / - Pz

N= 4

Fx = 4

Fy = 4

Bx = -4

By = -4