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CSE 5542
1/22/19

CSE 5542 HW1

① Scale Matrix

$$S_1 = \begin{bmatrix} 4.5 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 0 & 4.5 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Translation Matrix needed after scale is applied.

$$T_1 = \begin{bmatrix} 1 & 0 & 0 & 2.25 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 2.25 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Complete Transformation Matrix:

$$T = T_1 \cdot S_1$$

$$T = \begin{bmatrix} 1 & 0 & 0 & 2.25 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 2.25 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 4.5 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 \\ 0 & 0 & 4.5 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\boxed{T = \begin{bmatrix} 4.5 & 0 & 0 & 2.25 \\ 0 & 4 & 0 & 2 \\ 0 & 0 & 4.5 & 2.25 \\ 0 & 0 & 0 & 1 \end{bmatrix}}$$

Verifying Transformation Matrix T:

Let B equal the 4×8 matrix consisting of all vertices that make the unit box centered at the origin. So,

$$B = \begin{bmatrix} 0.5 & 0.5 & 0.5 & 0.5 & -0.5 & -0.5 & -0.5 & -0.5 \\ 0.5 & 0.5 & -0.5 & -0.5 & 0.5 & 0.5 & -0.5 & -0.5 \\ 0.5 & -0.5 & -0.5 & -0.5 & -0.5 & -0.5 & 0.5 & -0.5 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Let B' be the box after the transformation matrix T is applied to B. So,

$$B' = T \cdot B$$

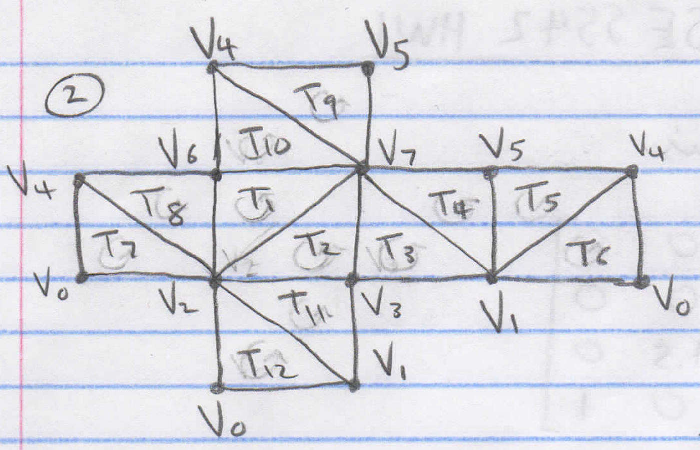
$$B' = \begin{bmatrix} 4.5 & 4.5 & 4.5 & 4.5 & 0 & 0 & 0 & 0 \\ 4 & 4 & 0 & 0 & 4 & 4 & 0 & 0 \\ 4.5 & 0 & 4.5 & 0 & 4.5 & 0 & 4.5 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Thus,

$$B' = [V_3 \ V_7 \ V_1 \ V_5 \ V_2 \ V_6 \ V_0 \ V_4]$$

Therefore, T is the correct transformation matrix for the unit box centered at the origin.

②



This diagiam is the box unfolded into its respective faces. The face consisting of T_1 and T_2 is the top of the box as seen on the homework webpage.

$T_1 = (V_6, V_2, V_7)$
$T_2 = (V_3, V_7, V_2)$
$T_3 = (V_3, V_1, V_7)$
$T_4 = (V_5, V_7, V_1)$
$T_5 = (V_5, V_1, V_4)$
$T_6 = (V_0, V_4, V_1)$
$T_7 = (V_0, V_2, V_4)$
$T_8 = (V_6, V_4, V_2)$
$T_9 = (V_5, V_4, V_7)$
$T_{10} = (V_6, V_7, V_4)$
$T_{11} = (V_3, V_2, V_1)$
$T_{12} = (V_0, V_1, V_2)$

Note: All triangles above were constructed using counter-clock-wise order using the diagiam above.