Tutorial 02: Solution

1

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -10 & 1 \end{bmatrix} \begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & -8 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

2

The points move to [0,0,10] and [0,0,6]. This is as expected since the centre of the object does not move, and the point [0,0,5] moves towards the centre (shrinks).

3

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -10 & 1 \end{bmatrix} \begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0.97 & -0.26 & 0 & 0 \\ 0.26 & 0.97 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & -8 & 1 \end{bmatrix} \begin{bmatrix} 0.97 & -0.26 & 0 & 0 \\ 0.26 & 0.97 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 10 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0.776 & -0.208 & 0 & 0 \\ 0.208 & 0.776 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

4

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0 \\ 0 & 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0.5 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 0.8 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0 \\ 0 & 0 & 0.8 & 0.4 \\ 0 & 0 & 2 & 1 \end{bmatrix}$$

It is singular. The last two rows are multiples of each other.

5
[0,0,10,1] transforms to [0,0,10,5] which normalises into Cartesian coordinate [0,0,2].
[0,0,5,1] transforms to [0,0,6,3] which normalises into Cartesian coordinate [0,0,2].
So both points project to the origin as required.

6
For a left hand axis system we have ***u***=***w***x***v***. = [0,0,-1].

7
C = [50,10,-10]
C.u = 10
C.v = 10
C.w = -50
hence we write down the transformation matrix as:

$$\begin{bmatrix} 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ -10 & -10 & 50 & 1 \end{bmatrix}$$