Tutorial 2: Transformations of Graphics Scenes

1 In a computer graphics animation scene an object is defined as a planar polyhedron. The object centre is located at position P = (0, 0, 10), and the scene is drawn, as normal, in perspective projection with the viewpoint at the origin and the view direction along the z-axis. Calculate the transformation matrix that will shrink the object in size by a factor of 0.8 towards its centre point.

2 Use your matrix of part 1 to check what happens to the points (0, 0, 10) and (0,0,5). Is your result what you expect?

3 In a different animation, the object, defined above is required to rotate clockwise, looking from the origin, while shrinking. In each successive frame it is to rotate by 15^o while shrinking to 0.8 of its original size. The rotation axis is to be the z axis, and the shrinkage is, as before, towards the object's centre. Given that $\text{Cos}(15^o) = .97$ and $\text{Sin}(15^o) = .26$, what is the transformation matrix that will achieve this animation?

4 The scene above is to be drawn in perspective projection with the plane of projection being $z = 2$. Find the combined transformation that will do animation of part 1 followed by the perspective projection. Is your matrix singular?

5 Use your matrix to find the transformation and perspective projection of the points (0, 0, 10) and (0, 0, 5) in homogenous coordinates and then in Cartesian coordinates.

6 The scene is to be viewed from a moving viewpoint specified by its position **C** and a left-handed viewing coordinate system $\{\boldsymbol{u}, \boldsymbol{v}, \boldsymbol{w}\}$. At one point in the animation the view direction is $\boldsymbol{w} = (-1, 0, 0)^T$, and the viewpoint is given by $\mathbf{C} = (50, 10, -10)$. Given that the view is in the horizontal plane ($\boldsymbol{v} = (0, 1, 0)^T$) find the value of $\boldsymbol{u}$.

7 Hence, or otherwise, find the viewing transformation matrix.