Tutorial 3: Manipulation of 3D Objects

Q1. Given the point (1,2,3) find an expression for each of the coordinates x', y' and z' of the same point as a function of a coordinate system (***u***,***v***,***w***,***C***).

Q2. A graphics scene is to be drawn from a moving viewpoint which is specified by a coordinate system labelled ***u***,***v***,***w***. The animation system is set up such that the view is always in the horizontal plane, so the vertical axis ***v***=[0,1,0]. At a particular moment in time, the viewpoint is located at position C = [10,5,5], and the direction of view ***w*** = [0.6, 0, -0.8].

a. Using the fact that ***u***,***v*** and ***w*** are orthogonal, calculate the vector ***u***. Hint: remember that the cross product between two vectors results in a vector whose direction is at right angles to both.
b. Calculate the transformation matrix that will transform each point of the scene to the ***u***,***v***,***w*** coordinate system.
c. Given that the view plane is to be at a distance of 2 units from the origin along the z direction, find the projection matrix for perspective projection, and the overall transformation/ projection matrix.
d. Use your matrix to find the projected coordinates of the point [10,1,0] in the original scene.

Q3. A scene in a computer game is to be transformed into a new co-ordinate system with the following specification:

- The origin is at $(10,15,5)$.
- The view direction (equivalent to the *w* axis direction) is defined by the vector $(-6,0,8)$.
- The new *u* axis is to remain perpendicular to the old *y* axis, so a vector in the *u* direction may be written $(p_x,0,p_z)$.
- The new *v* axis must have a positive *y* component, so a vector in the *v* direction may be written $(q_x,1,q_z)$.

Find the three unit vectors ***u***, ***v***, ***w*** describing the new co-ordinate system. Using these hence derive the desired transformation matrix.