

CZ2003 Tutorial 9 (2022/2023, Semester 1)

3D Transformations

1. The following matrix defines a 3D rotation transformation

$$\begin{bmatrix} \cos 60^\circ & 0 & -\sin 60^\circ & 0 \\ 0 & 1 & 0 & 0 \\ \sin 60^\circ & 0 & \cos 60^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Identify the rotation axis, rotation direction and rotation angle of this transformation.

2. Assuming a column represented position vector, write in a proper order individual matrices implementing the transformation of reflection about a straight line defined parametrically by $x = 1 - 2t, y = 0, z = 4t, t \in (-\infty, \infty)$. The final single matrix is not required.
3. An object is defined implicitly by $4x^4 + 4y^4 + z^2 - 4 = 0$. It undergoes an affine transformation defined by matrix T :

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

Derive the implicit representation of the transformed object, and display both the original object and the transformed object using ShapeExplorer.

4. A semi-circle on the ZX plane is shown in Fig.Q4 (left). It undergoes a sweeping by a full rotation about the Y-axis and a translation along the Y-axis by 2 units simultaneously, which produces a surface as shown in Fig.Q4 (right). By utilizing transformation matrices, derive a parametric representation of the surface.

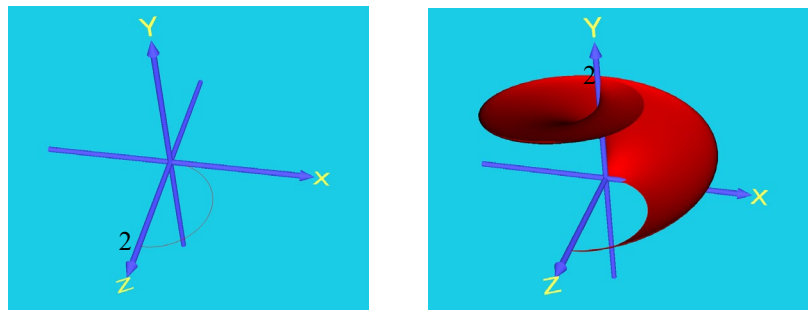


Fig.Q4