Visual Computing

2020/2021

Application Examples: Transformations and Projections

2D Transformations

1- Given the square, defined by the vertices (2, 2), (3, 2), (3, 3) and (2, 3), it is to be rotated around its center by an angle of 90 degrees.

a) Determine the transformation matrix, in *Homogeneous Coordinates*, that accomplishes the desired rotation.

b) Compute the coordinates of the transformed vertices and draw the square resulting from the rotation.

2- Given the triangle, defined by the vertices (2, 0), (4, 2) and (-1, 5), determine the triangle resulting from applying a symmetry transformation relative to the $y = x$ straight-line.

a) Determine the transformation matrix, in *Homogeneous Coordinates*, that accomplishes the desired symmetry.

b) Compute the coordinates of the transformed vertices and draw the triangle resulting from the symmetry.

3D Transformations

3- Consider the cube defined by the vertices:

V_1 (0, 0, 0)	V_2 (0, 1, 0)	V_3 (1, 1, 0)	V_4 (1, 0, 0)
V_5 (0, 0, 1)	V_6 (1, 0, 1)	V_7 (1, 1, 1)	V_8 (0, 1, 1)

Using *Homogeneous Coordinates*, determine the matrix that represents the transformation that is to be applied for the cube to rotate, by a 180 degrees angle, around the straight-line that passes through point (2, 0, 0) is parallel to the *YY'* axis.

a) Obtain the transformation matrix $R_Y(\theta)$ that represents the rotation transformation around the *YY'* axis, by an angle θ.

b) Obtain, through the concatenation of elementary transformations, the matrix *M(180)* representing the desired transformation. Explain the steps carried out.

c) Compute the coordinates of the transformed cube vertices.

d) Draw the transformed cube and check if the desired transformation was effectively carried out.

Projections

4- Consider the parallelepiped defined by the vertices:

V_1 (0, 0, 1)	V_2 (1, 0, 0)	V_3 (2, 0, 1)	V_4 (1, 0, 2)
V_5 (0, 1, 1)	V_6 (1, 1, 0)	V_7 (2, 1, 1)	V_8 (1, 1, 2)

We want to represent it using a *Perspective Projection*: the projection plane is the plane $z = 0$ and the center of projection is point (0, 0, 4).

a) Using *Homogeneous Coordinates*, determine the matrix that represents the corresponding projection transformation. Explain the steps carried out.

b) Compute the coordinates of the projected vertices.

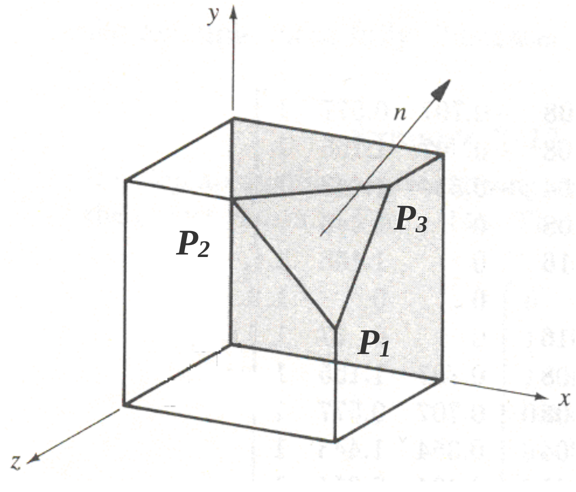
c) Draw the projected parallelepiped. Identify the projected vertices and the visible edges.

d) Given the obtained projection, classify it. Justify your answer.

5- Given the model in the figure, we want to obtain an auxiliary view that shows the true size of the model's triangular face.

The vertices defining the triangular face are: P1 = (1, 0.5, 1), P2 = (0.5, 1, 1) and P3 = (1, 1, 0.5).

Using *Homogeneous Coordinates*, determine the global transformation matrix that allows obtaining the desired auxiliary view.



(Rogers / Adams, Mathematical Elements for Computer Graphics, 2nd Ed.)