Introduction to Computer Graphics

2023/2024

Application Examples: Projections

1- 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.

2- Consider the cube centered at (0, 0, 0) and defined by the vertices:

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

The cube has to be represented using a **Perspective Projection**: the projection center is point **(3, 0, 0)** and the projection plane is ***x* = 0**.

a) Define, using Homogeneous Coordinates, the corresponding projection matrix, Justify the steps taken.

b) Compute the coordinates of the projected vertices.

c) Draw the projected cube and check if you obtained the expected result.

3- Given a cube defined by the following vertices:

V_1 (10, 10, -10)	V_2 (10, -10, -10)	V_3 (30, -10, -10)	V_4 (30, 10, -10)
V_5 (10, 10, -30)	V_6 (10, -10, -30)	V_7 (30, -10, -30)	V_8 (30, 10, -30)

We want to obtain the cube representation using ***Perspective Projection***: the projection plane is ***y* = 0** and the projection centre is point **(0, 60, 0)**.

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

b) Compute the coordinates of the vertices defining the projected cube.

c) Sketch the projected cube. Identify the projected vertices and list the visible edges.

d) According to the features of the sketched cube, classify the projection obtained. Explain your answer.

4- Given a square pyramid defined by the following vertices:

V_1 (1, 0, 1)	V_2 (1, 0, −1)	V_3 (−1, 0, −1)	V_4 (-1, 0, 1)	V_5 (0, 2, 0)

We want to represent the pyramid using ***Perspective Projection***: the projection center is the point **(−2, 0, 0)** and the projection plane is the plane $x = 0$.

a) Obtain, using *Homogeneous Coordinates*, the matrix representing the corresponding projection transformation. Explain all the steps carried out.

b) Compute the coordinates of the projected pyramid vertices.

c) Classify the obtained projection. Justify your answer.

5- Consider the **cube** defined by the vertices:

V_1 (0, 1, 1)	V_2 (0, 1, −1)	V_3 (0, 3, −1)	V_4 (0, 3, 1)
V_5 (−2, 1, 1)	V_6 (−2, 1, −1)	V_7 (−2, 3, −1)	V_8 (−2, 3, 1)

The cube has to be represented using a **Perspective Projection**: the projection center is point **(4, 0, 0)** and the projection plane is $x = 0$.

a) Define, using Homogeneous Coordinates, the corresponding projection matrix, Justify the steps taken.

b) Compute the coordinates of the projected vertices.

c) Draw the projected cube and check if you obtained the expected result. What **type of projection** did you get?