Assignment 5: Culling, Back Face Removal and Clipping

Topics

- Build the model to world matrix for the airplane using the airplane’s three axis
- Transform all objects from model to world
- Build the world to camera matrix using the orthogonal method (three types of cameras from assignment 3 need to work)
- Build the perspective matrix
- Generate the six frustrum planes in world space
- Perform culling in world space using method discussed in class
- Perform back face removal test in world space
- Perform clipping against near plane in world space
- Transform new faces to camera space
- Transform faces to projection space, then NDC space then viewport space
- Calculate the depth buffer value
- Create the depth buffer array
- Clear the depth buffer array every loop to the far value
- Rasterize the triangle using depth buffer

Description

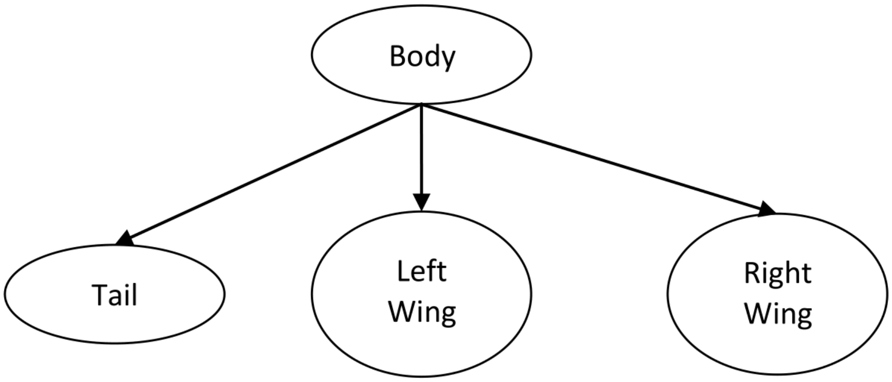
Given an input file “input.txt” containing the following information:

- The camera/projection window left, right, top, bottom, focal, near plane and far plane values (ignore the near and far values for this assignment)
- A vertex list defining a cube centered at the origin and of size 1 (defined in model space)
- A face list holding the indexes to the triangles in the cube
- A face color list holding the colors of the given faces
- A texture coordinates list holding the texture coordinates of all vertexes in the cube (number of texture coordinates is equal to number of faces * 3)

Using the cube vertexes database we will build an airplane having the following body parts:

- Body
- Tail (attached to the body)
- Left and Right Wings (both attached to the body)

The following diagram will show the airplane hierarchy:



The assignment is about culling objects that are outside the viewing frustrum to avoid needless computations. In addition, the faces that are not facing the camera of the objects that are within the view frustrum can be removed in order to avoid needless computations. Finally, in order to avoid projection problems, clipping is implemented against the near plane.

The application should:

1. Read the input file
2. Accept from the keyboard the user input in order to navigate an object (the airplane)
3. Compute the camera position and target.
4. Build the camera transformation according to the user input
5. Allow to swap between cameras
6. Populate the world with a few cubes
7. Compute depth buffer z value
8. Cull, check for back face removal, and clip (against near plane) in world space
9. Project the vertexes
10. Map the vertexes from the projection plane to the view-port
11. Rasterize on the screen using depth buffer

Airplane information

- Body dimensions or scale values: Sx=15,Sy=12.5, Sz=40
- Body Initial Position: Anywhere along the Negative z-axis

- Tail dimensions or scale values: Sx=5, Sy=7.5, Sz=10
- Tail Initial position: (0, 10, -15)

- Left Wing dimensions or scale values: Sx=20, Sy=5, Sz=10
- Left Wing Initial position: (-17.5, 0, 0)

- Right Wing dimensions or scale values: Sx=20, Sy=5, Sz=10
- Right Wing Initial position: (17.5, 0, 0)

Camera

Camera properties should also be extracted from the file. Left/Right give information about the width of the window and same with Top/Bottom for the height. For this assignment *far* and *near* data should be added to the perspective matrix.

When creating the view matrix, make sure that the view vector gets aligned with the **negative Z axis** and that your perspective matrix also takes that into account.

Scene

Along with the airplane keep the grid from Assignment 3. The grid needs to have cubes of scale (10, 10, 10) throughout the XZ-plane. Add a 5x5 grid of cubes from positions (-100, 0,-100) to (100, 0, 100).

Input

- 1: wireframe mode
- 2: solid mode
- 3: first person mode
- 4: third person mode
- 5: rooted camera mode
- a: Rolls airplane body / Rotate around forward (cw)
- d: Rolls airplane body / Rotate around forward (ccw)
- q: Yaws airplane body / Rotate around up (ccw)
- e: Yaws airplane body / Rotate around up (cw)
- w: Pitches airplane body / Rotate around right (cw)
- s: Pitches airplane body / Rotate around right (ccw)
- space: Move airplane body forward
- z: Decrease camera distance
- x: Increase camera distance
- h: Decrease camera height
- y: Increase camera height

Grade Breakdown

Feature	Grade %
Frustum plane computation	20%
Culling	20%
Back face removal	20%
Clipping with near plane	30%
Code quality	10%