2023 Computer Graphics HW1 – Airplane

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Implementation

TODO#0: Change window title to "HW1 - `your student id`"

```
glfwSetWindowTitle(window, "HW1 - 312553024");
```

TODO#1-1: Calculate lookAt matrix

```
// Step 1: Rotate original_front and original_up using this->rotation
glm::vec3 rotatedFront = rotation * original_front;
glm::vec3 rotatedUp = rotation * original_up;

// Step 2: Calculate the right vector by taking the cross product
glm::vec3 right = glm::cross(rotatedFront, rotatedUp);

// Step 3: Calculate the view matrix with the position
viewMatrix = glm::lookAt(position, position + rotatedFront, rotatedUp);
```

TODO#1-2: Calculate perspective projection matrix

```
// Calculate perspective projection matrix
projectionMatrix = glm::perspective(FOV, aspectRatio, zNear, zFar);
```

TODO#2: Render body, wing, tail

2-1 Render body

畫出圓柱體，先畫外圍，再畫頂部和底部

```
void draw_cylinder(float radius, float height, int segments) {
    // Draw a cylinder with top and bottom faces and the specified parameters
    float angleIncrement = 2.0f * M_PI / segments;

    // Draw the top face
    glBegin(GL_POLYGON);
    glNormal3f(0.0f, 1.0f, 0.0f);  // Define the normal for lighting
    for (int i = 0; i < segments; i++) {
        float angle = static_cast<float>(i) * angleIncrement;
        float x = radius * cos(angle);
        float z = radius * sin(angle);
        glVertex3f(x, height / 2.0f, z);
    }
    glEnd();

    // Draw the bottom face
    glBegin(GL_POLYGON);
    glNormal3f(0.0f, -1.0f, 0.0f);  // Define the normal for lighting
    for (int i = 0; i < segments; i++) {
        float angle = static_cast<float>(i) * angleIncrement;
        float x = radius * cos(angle);
        float z = radius * sin(angle);
        glVertex3f(x, -height / 2.0f, z);
    }
    glEnd();

    // Draw the side faces
    glBegin(GL_QUAD_STRIP);
    for (int i = 0; i <= segments; i++) {
        float angle = static_cast<float>(i) * angleIncrement;
        float x = radius * cos(angle);
        float z = radius * sin(angle);

        glNormal3f(x, 0.0f, z);  // Define the normal for lighting

        float y1 = -height / 2.0f;
        float y2 = height / 2.0f;

        glVertex3f(x, y1, z);  // Bottom
        glVertex3f(x, y2, z);  // Top
    }
    glEnd();
}
```

先移動再以 X 軸旋轉-90 度，然後將顏色改成藍色

```
void render_body() {
    // Render the body (cylinder) with top and bottom faces
    glPushMatrix();
    glTranslatef(0.0f, 0.5f, 0.0f);            // Translate to the desired position
    glRotatef(-90.0f, 1.0f, 0.0f, 0.0f);       // Rotate the body by 90 degrees around the X-axis
    glColor3f(BLUE);                           // Set the color to red
    draw_cylinder(0.5f, 4.0f, CIRCLE_SEGMENT); // Render the body using draw cylinder
    glPopMatrix();
}
```

2-2 Render wings

先畫出長方體

```
void draw_rectangle(float length, float width, float height) {
  // Half-dimensions for easier calculations
  float halfLength = length / 2.0f;
  float halfWidth = width / 2.0f;
  float halfHeight = height / 2.0f;

  // Draw the wing as a rectangular cuboid
  glBegin(GL_QUADS);

  // Front face
  glNormal3f(0.0f, 0.0f, 1.0f);
  glVertex3f(-halfLength, -halfHeight, halfWidth);
  glVertex3f(halfLength, -halfHeight, halfWidth);
  glVertex3f(halfLength, halfHeight, halfWidth);
  glVertex3f(-halfLength, halfHeight, halfWidth);

  // Back face
  glNormal3f(0.0f, 0.0f, -1.0f);
  glVertex3f(-halfLength, -halfHeight, -halfWidth);
  glVertex3f(halfLength, -halfHeight, -halfWidth);
  glVertex3f(halfLength, halfHeight, -halfWidth);
  glVertex3f(-halfLength, halfHeight, -halfWidth);

  // Right face
  glNormal3f(1.0f, 0.0f, 0.0f);
  glVertex3f(halfLength, -halfHeight, halfWidth);
  glVertex3f(halfLength, -halfHeight, -halfWidth);
  glVertex3f(halfLength, halfHeight, -halfWidth);
  glVertex3f(halfLength, halfHeight, halfWidth);

  // Left face
  glNormal3f(-1.0f, 0.0f, 0.0f);
  glVertex3f(-halfLength, -halfHeight, halfWidth);
  glVertex3f(-halfLength, -halfHeight, -halfWidth);
  glVertex3f(-halfLength, halfHeight, -halfWidth);
  glVertex3f(-halfLength, halfHeight, halfWidth);

  // Top face
  glNormal3f(0.0f, 1.0f, 0.0f);
  glVertex3f(-halfLength, halfHeight, halfWidth);
  glVertex3f(halfLength, halfHeight, halfWidth);
  glVertex3f(halfLength, halfHeight, -halfWidth);
  glVertex3f(-halfLength, halfHeight, -halfWidth);

  // Bottom face
  glNormal3f(0.0f, -1.0f, 0.0f);
  glVertex3f(-halfLength, -halfHeight, halfWidth);
  glVertex3f(halfLength, -halfHeight, halfWidth);
  glVertex3f(halfLength, -halfHeight, -halfWidth);
  glVertex3f(-halfLength, -halfHeight, -halfWidth);

  glEnd();
}
```

再移動並改成紅色，因為有兩片機翼，所以做兩次

```
void render_wings() {
 // Render the wings of airplane
 glPushMatrix();
 glTranslatef(2.0f, 0.5f, 0.0f);             // Translate to the desired position
 glColor3f(RED);                            // Set the color to red
 draw_rectangle(4.0f, 1.0f, 0.5f);  // Render the body using drawCylinder
 glPopMatrix();

 // Render the wings of airplane
 glPushMatrix();
 glTranslatef(-2.0f, 0.5f, 0.0f);  // Translate to the desired position
 glColor3f(RED);                    // Set the color to red
 draw_rectangle(4.0f, 1.0f, 0.5f);  // Render the body using drawCylinder
 glPopMatrix();
}
```

2-3 Render tail

先畫出三角形

```
void draw_triangle(float bottomEdge, float height1, float height2) {
 glBegin(GL_TRIANGLES);
 // Face 1
 //glNormal3f(0.0f, 0.0f, 1.0f);                 // Normal pointing along the Z-axis
 glVertex3f(0.0f, 0.0f, 0.0f);                  // Top vertex
 glVertex3f(bottomEdge / 2.0f, 0.0f, height1);   // Bottom-left vertex
 glVertex3f(-bottomEdge / 2.0f, 0.0f, height1);  // Bottom-right vertex

 // Face 2
 //glNormal3f(0.0f, 0.0f, 1.0f);                 // Normal pointing along the Z-axis
 glVertex3f(0.0f, 0.0f, 0.0f);                  // Top vertex
 glVertex3f(0.0f, -height2, height1);           // Bottom-left vertex
 glVertex3f(bottomEdge / 2.0f, 0.0f, height1);   // Bottom-right vertex

 // Face 3
 //glNormal3f(0.0f, 0.0f, 1.0f);                 // Normal pointing along the Z-axis
 glVertex3f(0.0f, 0.0f, 0.0f);                  // Top vertex
 glVertex3f(0.0f, -height2, height1);           // Bottom-left vertex
 glVertex3f(-bottomEdge / 2.0f, 0.0f, height1);   // Bottom-right vertex

 // Face 4
 //glNormal3f(0.0f, 0.0f, 1.0f);                 // Normal pointing along the Z-axis
 glVertex3f(-bottomEdge / 2.0f, 0.0f, height1);  // Top vertex
 glVertex3f(0.0f, -height2, height1);           // Bottom-left vertex
 glVertex3f(bottomEdge / 2.0f, 0.0f, height1);   // Bottom-right vertex
 glEnd();
}
```

再移動並改成綠色

```
void render_tail() {
  // Render the tail of the airplane
  glPushMatrix();
  // Translate to the correct position relative to the body
  glTranslatef(0.0f, 0.5f, 2.0f);
  // Rotate the tail if needed
  // glRotatef(angle, 1.0f, 0.0f, 0.0f);  // Rotate the tail around the X-axis

  // Set the color (e.g., GREEN or your desired color)
  glColor3f(GREEN);

  // Draw the tail as a tetrahedron (adjust dimensions as needed)
  draw_triangle(2.0f, 1.0f, 0.5f);

  glPopMatrix();
}
```

TODO#3: Render the airplane

呼叫剛才的 function

```
render_body();
render_wings();
render_tail();
```

TODO#4

沒時間做了...

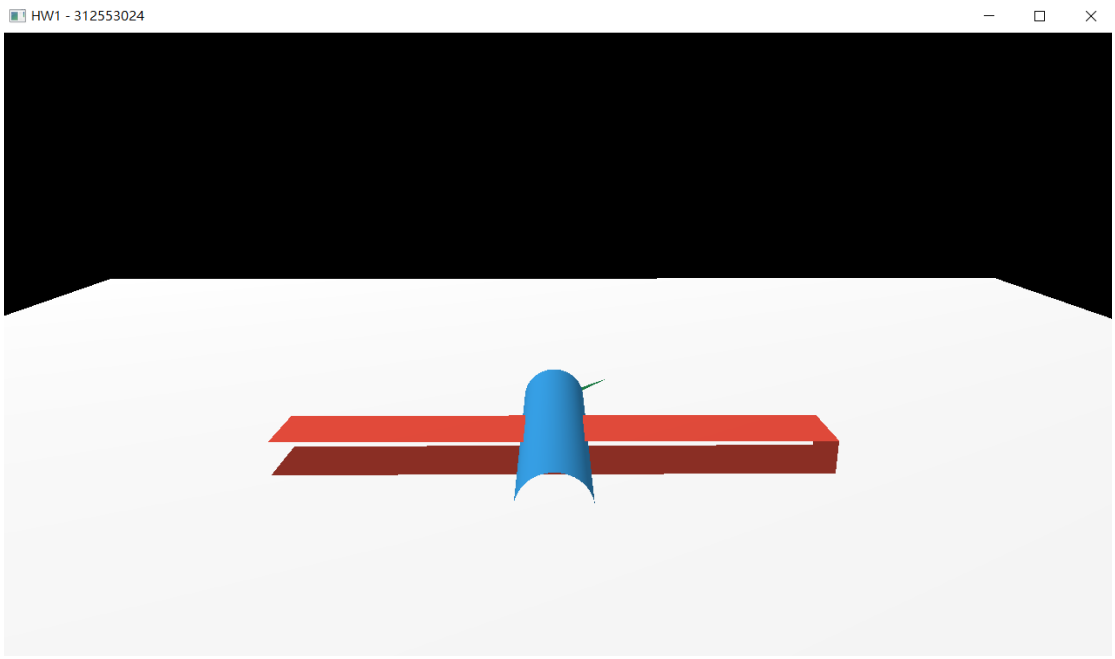
Problems you encountered

Render 不知道哪裡出了問題，正面看都正常，但從背面看就破圖了，因為對

OpenGL 不熟，Debug 老半天還是搞不定，然後期中又很忙，所以後面的部分

就都沒做完了 QQ

我的飛機長的像這樣：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