CS411: Computer Graphics

Lab 03 - Report

Affine Transform 2D with OpenGL

NGUYỄN HỮU HOÀNG MINH   22125058

HO CHI MINH CITY, MARCH 2025

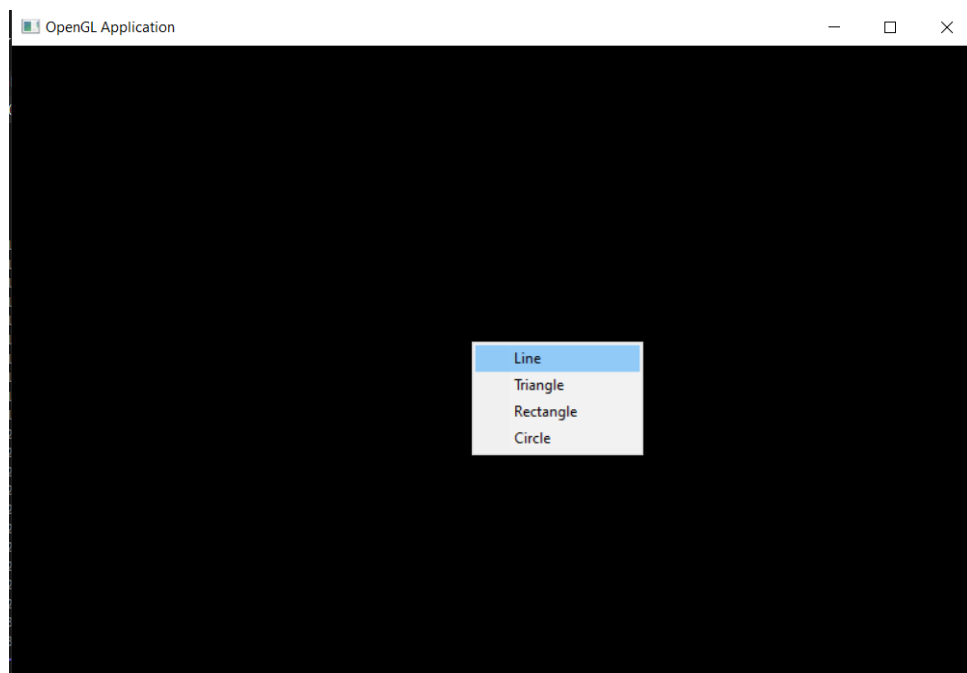# Contents

Part I

Drawing shape and selection

1 Context Menu

The context menu contains 4 available shapes: Line, Triangle, Rectangle, Circle.
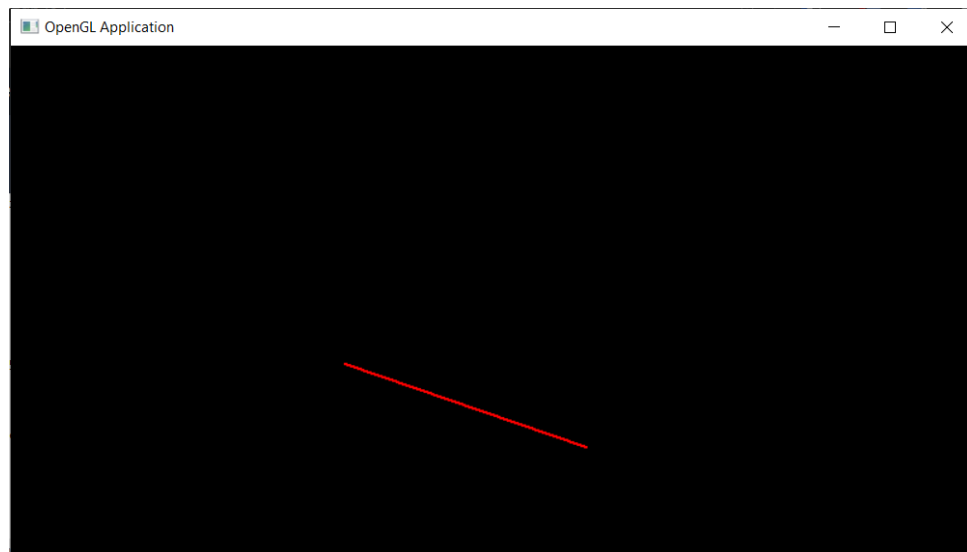

2 Drawing shapes

2.1 Lines

Right click on the screen then choose the option "Line" in the context menu
Then

- First left click to choose the starting point of the line
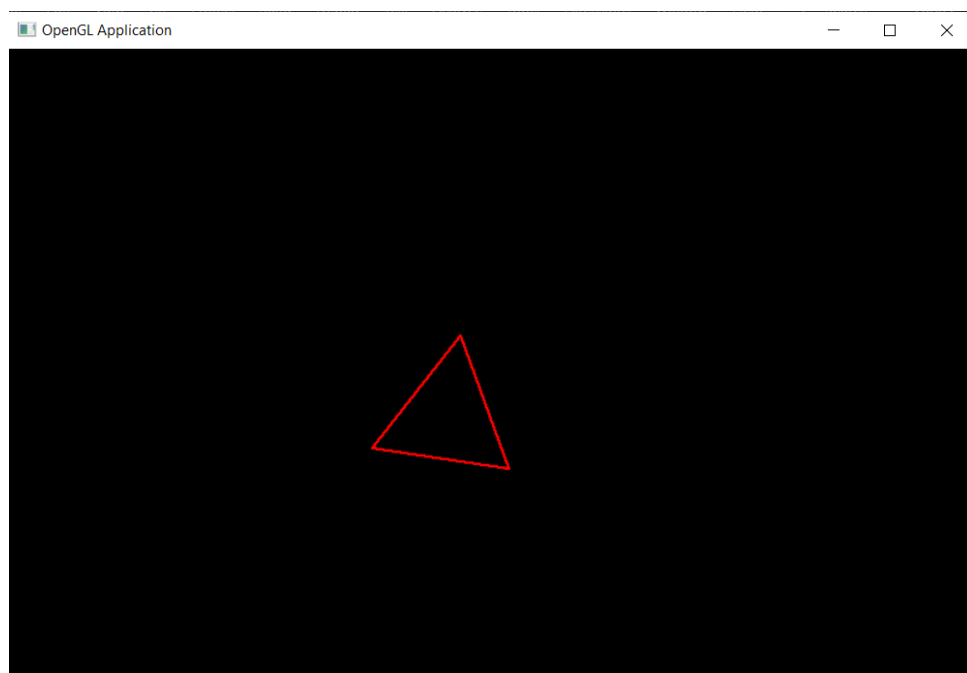
- Second left click to choose the ending point of the line

2.2   Triangle

Right click on the screen then choose the option "Triangle" in the context menu
Then

- First left click to choose the first coordinates of the triangle.

- Second left click to choose the second coordinates of the triangle.

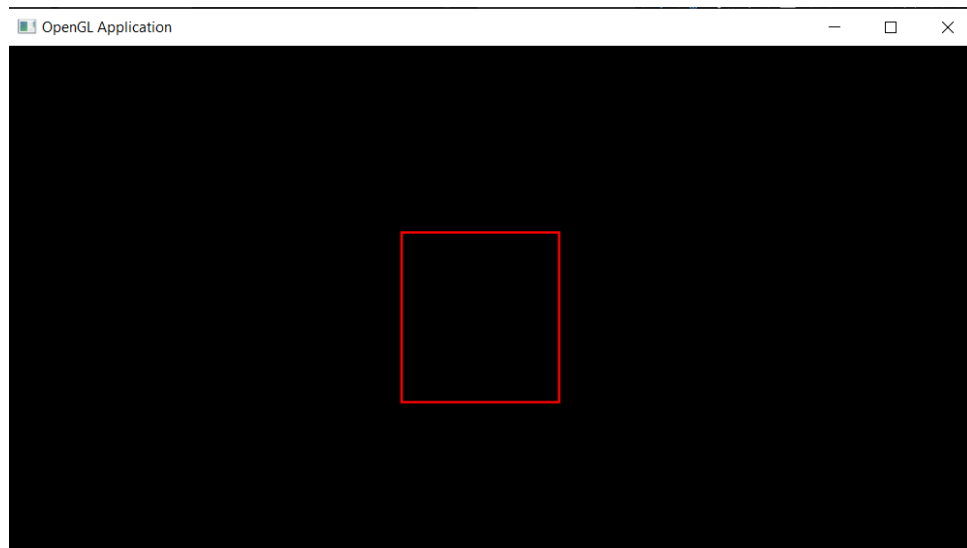- Third left click to choose the third coordinates of the triangle.

2.3 Rectangle

Right click on the screen then choose the option "Rectangle" in the context menu
Then

- First left click to choose the first coordinates of the triangle, let call it (x_1, y_1).

- Second left click to choose the second coordinates of the triangle, let call it (x_2, y_2).

Then the rectangle will be drawn with the lines from (x_1, y_1) to (x_1, y_2), (x_1, y_2) to (x_2, y_2), (x_2, y_2) to (x_2, y_1) and (x_2, y_1) to (x_1, y_1).
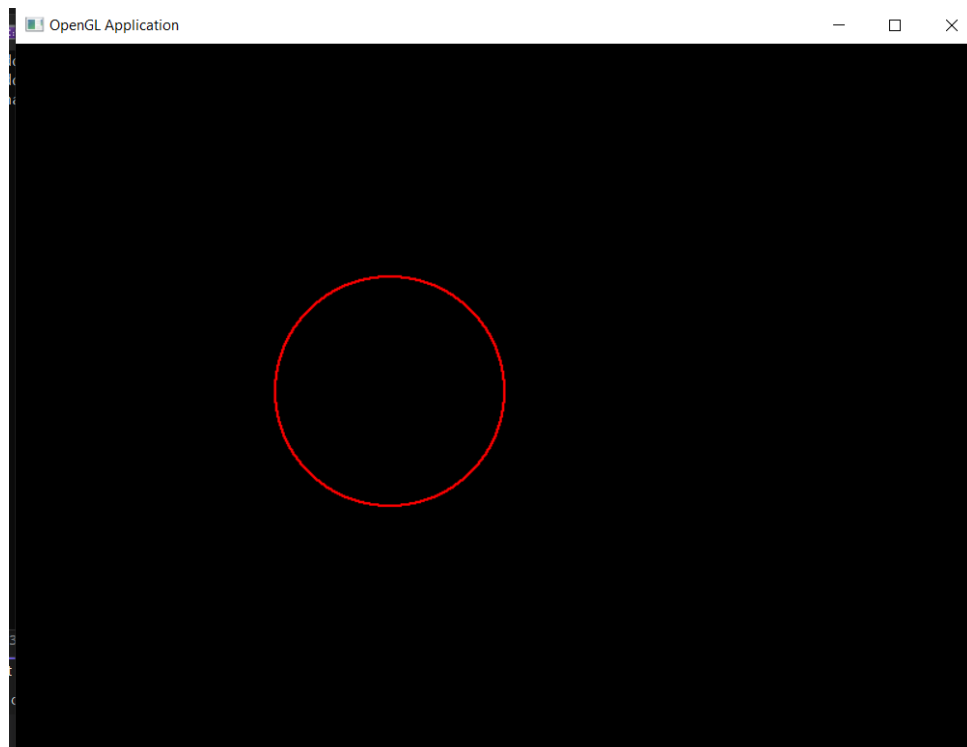

2.4 Circle

Right click on the screen then choose the option "Rectangle" in the context menu
Then

- First left click to choose the center of the circle (x_1, y_1).

- Second left click to choose one point that is on the circle (x_2, y_2).

Then the radius of the circle is calculated as $(x_2 - x_1, y_2 - y_1)$
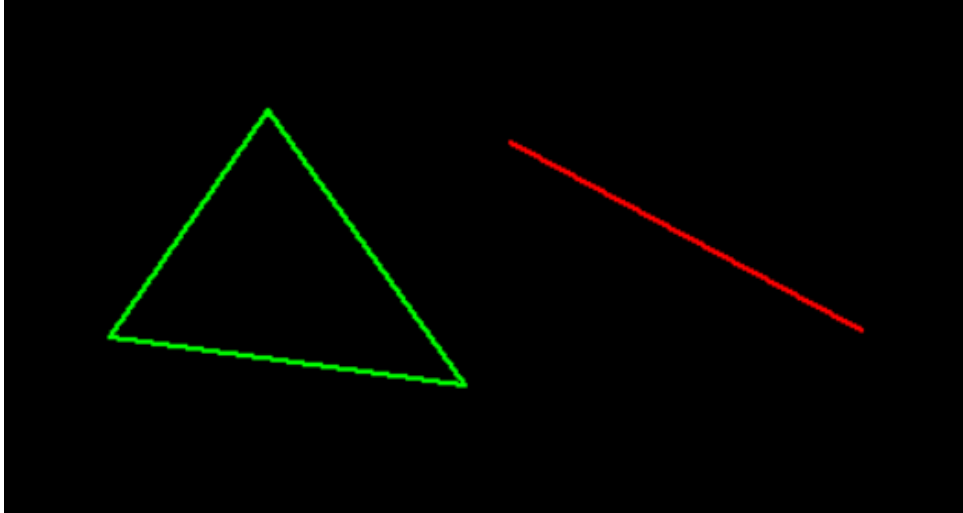
3 Select object

When you have drawn an object to the screen, the context menu will be updated with all the current available objects, labeled with their shape name and the order which they are created, choose one of them to select the object.

The object is being selected will be colored with green color.

Part II

Affine Transformation

4   Rotation

4.1   Lines Rotation

First we calculate the focus point of of the line by the formula:

$$x_f = (x_1 + x_2)/2$$

$$y_f = (y_1 + y_2)/2$$

Then we subtract each points with the focus point to move it to the origin $(x_{1n}, y_{1n}) = (x_1 - x_f, y_1 - y_f)$, $(x_{2n}, y_{2n}) = (x_2 - x_f, y_2 - y_f)$

We rotate the new line with the formula[1]:

$$\begin{bmatrix} x_{1n} & y_{1n} \end{bmatrix} = \begin{bmatrix} x_{1n} & y_{1n} \end{bmatrix} \begin{bmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{bmatrix}$$

$$\begin{bmatrix} x_{2n} & y_{2n} \end{bmatrix} = \begin{bmatrix} x_{2n} & y_{2n} \end{bmatrix} \begin{bmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{bmatrix}$$

Finally we add the focus point to each new points to move back to the original position.

$$(x_1, y_1) = (x_{1n} + x_f, y_{1n} + y_f)$$

$$(x_2, y_2) = (x_{2n} + x_f, y_{2n} + y_f)$$

4.2 Triangle Rotation and Rectangle Rotation

For the triangle rotation and rectangle rotation, we do the same as the line rotation, each shape with different focus point calculation.

For triangle, the focus point is calculated by

$$(x_f, y_f) = \left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3} \right)$$

For rectangle, the focus point is calculated by

$$(x_f, y_f) = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

4.3 Circle Rotation

The circle rotation is the same as before so we don't need to do anything.

5 Translation

For translation transformation, each points of the object will be move by an amount of (tr_x, tr_y), calculated by the formula[1]:

$$(x, y) = (x + tr_x, y + tr_y)$$

6   Scaling

For scaling transformation, each points of the object will be calculated by the formula[1]:

$$\begin{bmatrix} x & y \end{bmatrix} = \begin{bmatrix} x & y \end{bmatrix} \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$$

with (S_x, S_y) is the scale factor of horizontal and vertical.

References

[1] *2D Transformation slides - CS411 Computer Graphics - HCMUS.*