Assignment - 3 (A3)

Problem definition :

Write a C++ program to draw 2D object and perform following basic transformations

i) Scaling
ii) Translation
iii) Rotation

Use operator overloading.

Objectives : To understand different transformations and matrices associated with them

Outcomes : To be able to apply operator overloading concepts to perform different operations on a given shape.

H/w & S/w requirements :

- 64 bit OS
- i3 intel core
- Qt creator

Theory :

- Transformations refer to changing properties or dimensions of a figure without changing the base shape of the figure.
- Transformations can be achieved using Matrix Multiplication.
- The vertex matrix of a shape is given as follows.

$$\begin{bmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ \vdots & & \\ x_n & y_n & 1 \end{bmatrix}_{n \times 3}$$

- 3 basic transformations are:
  i) Translation
  ii) Scaling
  iii) Rotation

i) Translation refers to shifting the position of an object without altering dimensions. The Matrix to be multiplied to vertex matrix for translating x, y units is

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ x & y & 1 \end{bmatrix}$$

ii) Scaling refers to increasing / decreasing the size of an object by a factor S_x in x direction & S_y in y direction. The Matrix to be multiplied to vertex Matrix is:

$$\begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Translation & scaling can be achieved by following Matrix

$$\begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ x & y & 1 \end{bmatrix}$$

ii) Rotation of the shape doesn't affect its size or position. If the object is to be rotated by an angle θ then transformation matrix is about (0,0)

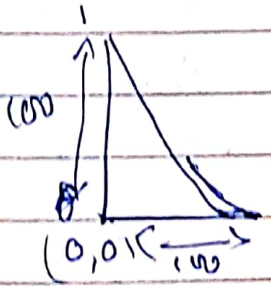
$$\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

New Matrix : vertex Matrix x Transformation Matrix.

Test cases :

Input	expected o/p	actual o/p	Result.

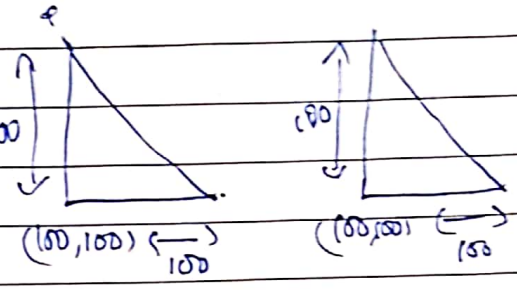
Initial shape



Translation

$T_x = 100$

$T_y = 100$

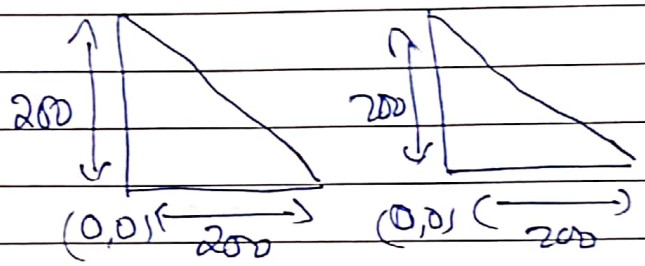


Success

Scaling

$S_x = 2$

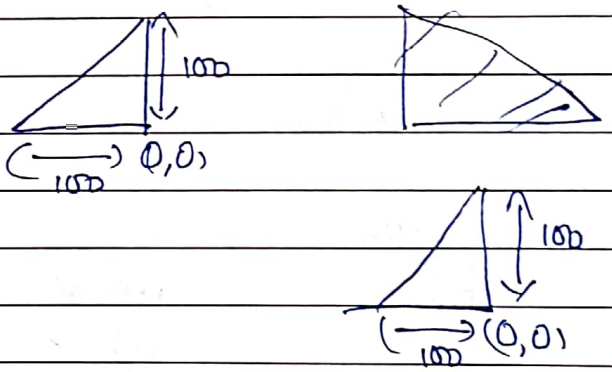
$S_y = 2$



Success

Rotation

$\theta = +90^\circ$



Success

Conclusion:

Thus we were able to perform transformation on an object using Matrix Multiplication and operator overloading.