Assignment 6

Problem Statement:
Implement following 2D transformations on the object with respect to axis : –i) Scaling ii) Rotation about arbitrary point iii) Reflection

Objective:
1.To understand the 2 D Homogeneous coordinate system
2. Understand and Implement 2D transformations in Laboratory.

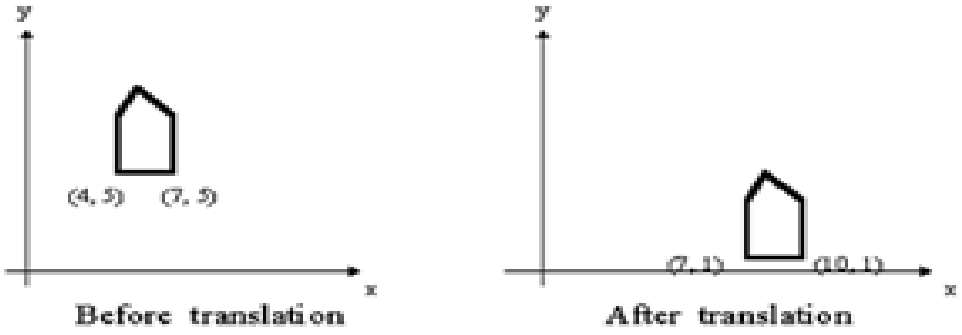
Outcome:
To implement transformation operations.

CO Relevance: CO5

PO/PSOs Relevance: PO1, PO2, PO5, PO6

Theory Concepts*:*

Translation:
Translation is defined as moving the object from one position to another position along straight line path.



We can move the objects based on translation distances along x and y axis.
tx denotes translation distance along x-axis and ty denotes translation distance along y axis.

Translation Distance: It is nothing but by how much units we should shift the object from one location to another along x, y-axis.

Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:

X' =x + tx

Y' =y + ty

Scaling:

Scaling refers to changing the size of the object either by increasing or decreasing. We will increase or decrease the size of the object based on scaling factors along x and y -axis.
If (x, y) are old coordinates of object, then new coordinates of object after applying scaling transformation are obtained as:

x'= x*sx

y'= y*sy

sx and sy are scaling factors along x-axis and y-axis. we express the above equations in matrix form as:

$$\begin{pmatrix} X' \\ Y' \end{pmatrix} = \begin{pmatrix} X \\ Y \end{pmatrix} \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$$

Rotation :

A rotation repositions all points in an object along a circular path in the plane centered at the pivot point. We rotate an object by an angle theta

New coordinates after rotation depend on both x and y

x' = xcosθ -y sinθ
y' = xsinθ+ ycosθ
or in matrix form:

P' = R • P,
R-rotation matrix.

$$R = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

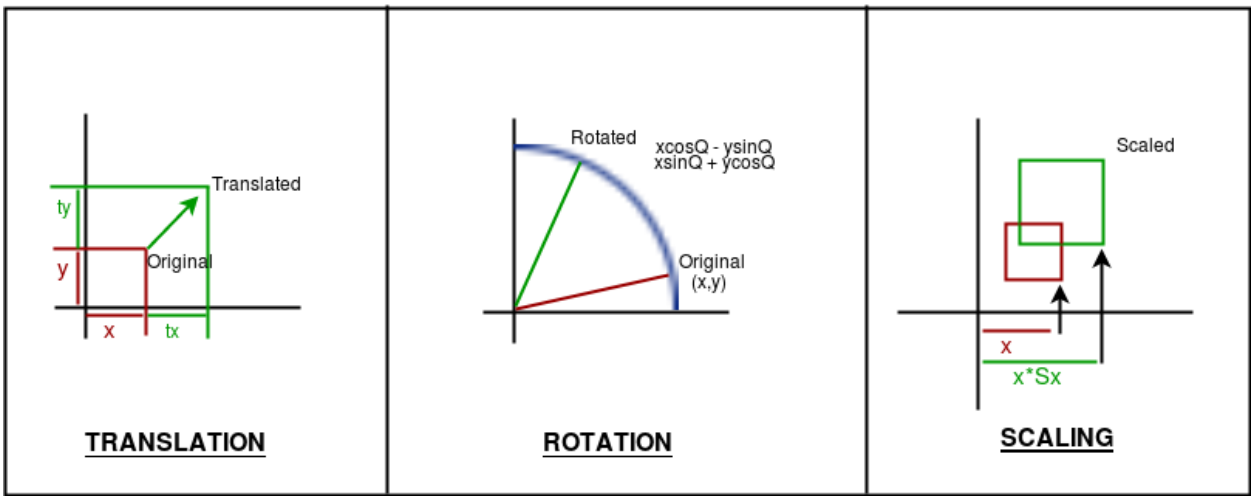
Formula: X = xcosA - ysinA
Y = xsinA + ycosA,

A is the angle of rotation.

The above formula will rotate the point around the origin.
To rotate around a different point, the formula:

X = cx + (x-cx)*cosA - (y-cy)*sinA,
Y = cx + (x-cx)*sinA + (y-cy)*cosA,
cx, cy is centre coordinates,
A is the angle of rotation.

The OpenGL function is glRotatef (A, x, y, z).



Reflection:
It is a transformation which produces a mirror image of an object. The mirror image can be either about x-axis

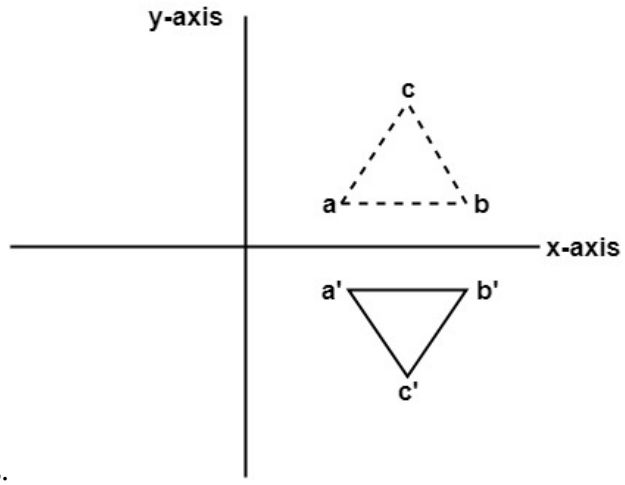
or y-axis. The object is rotated by180°.

Types of Reflection:
Reflection about the x-axis
Reflection about the y-axis
Reflection about an axis perpendicular to xy plane and passing through the origin
Reflection about line y=x

1. Reflection about x-axis: The object can be reflected about x-axis with the help of the following matrix

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

In this transformation value of x will remain same whereas the value of y will become negative. Following figures shows the reflection of the object axis. The object will lie another side of the x-

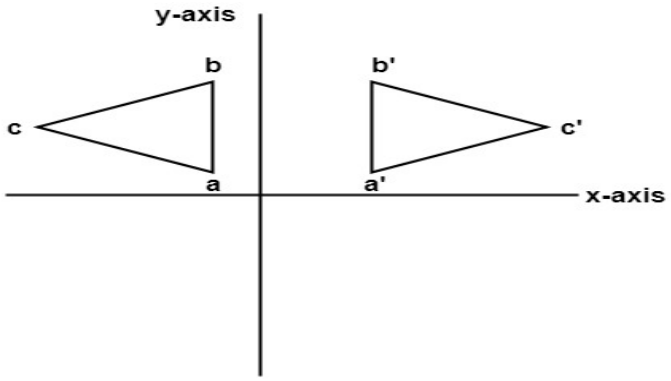


axis.

2. Reflection about y-axis: The object can be reflected about y-axis with the help of following transformation matrix

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

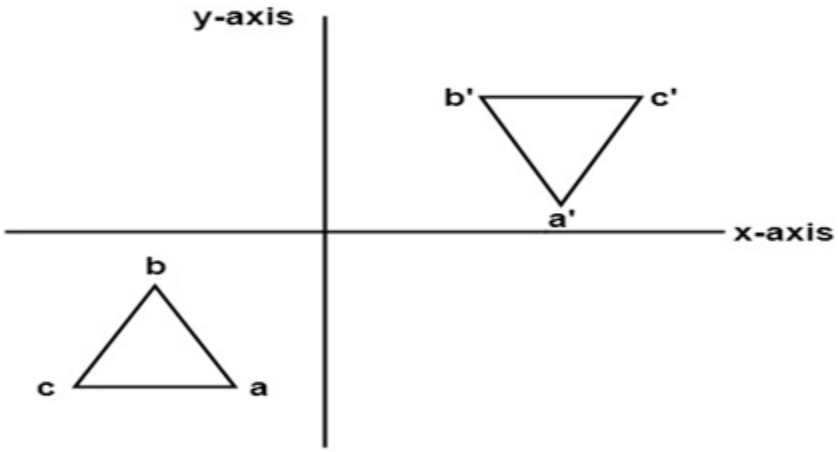
Here the values of x will be reversed, whereas the value of y will remain the same. The object will lie another side of the y-axis.
The following figure shows the reflection about the y-axis



3. Reflection about an axis perpendicular to xy plane and passing through origin:

In the matrix of this transformation is given below

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

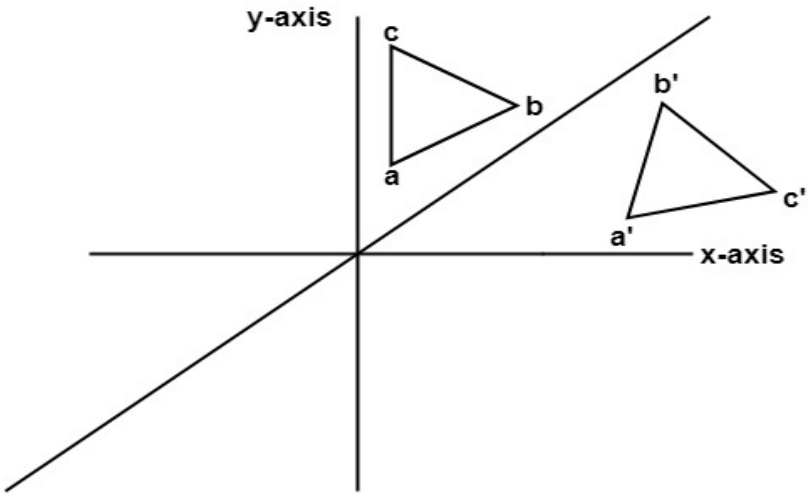


In this value of x and y both will be reversed. This is also called as half revolution about the origin.

4. Reflection about line y=x:

The object may be reflected about line y = x with the help of following transformation matrix

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



First of all, the object is rotated at 45°. The direction of rotation is clockwise. After it reflection is done concerning x-axis. The last step is the rotation of y=x back to its original position that is counterclockwise at 45°.

Output:
(Execute the program and attach the printout here)

Conclusion:
In This way we have studied that how to perform 2 dimensional operations on objects

Viva Questions:

1. What is the matrix for scaling?
2. What is the matrix for translation?
3. What is the matrix for rotation (clockwise & anticlockwise)?
4. What is matrix for relection (about X-axis and Y-axis)?
5. Where we can use homogeneous coordinates?
6. What is the matrix for shear (x-shear, y-shear)?

Date:	
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