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Assignment - A3

Title : Write C++ / Java program to draw 2-D object and perform following basic transformations.

1) Scaling
2) Translation
3) Rotation.

Objective : To study different transformations involved in drawing a 2D object.

Outcome : Student will be able to apply different transformations on a 2-D object.

Theory :

1) Scaling :- It is used to alter or change the size of objects. The change is done using scaling factors. There are two scaling factors i.e S_x in x direction, S_y in y direction. If the original position is x and y, scaling factors are S_x and S_y then the value of coordinates after scaling will be x_1, y_1.

If S_x and S_y are not equal then scaling will occur but it will elongate or distort the picture.

If S_x and S_y are less than 1, then the size of the object will be reduced but

if they are higher than 1, then the size of object will be enlarged.

If $S_x = S_y$ then it is called uniform scaling and if not then it is called differential scaling.

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

2) Translation :- It is the straight line movement of an object from one position to another.

To translate a point from coordinate position (x, y) to another (x_1, y_1) we add algebraically the & translation distances t_x and t_y to original coordinate

$$x_1 = x + t_x$$
$$y_1 = y + t_y$$

The translation pair (T_x, T_y) is called as shift vector.

Matrix
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 1 \end{bmatrix}$$

Rotate :- It is a process of changing the angle of the object
Rotation can be clockwise or anticlockwise
For rotation we have to specify the angle of rotation and rotation point. Rotation point is called a pivot point.

Matrix

For anticlockwise rotation

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

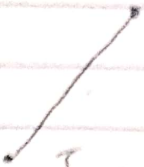
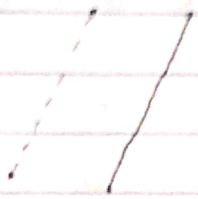
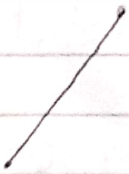
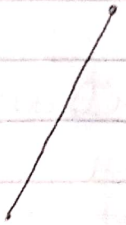
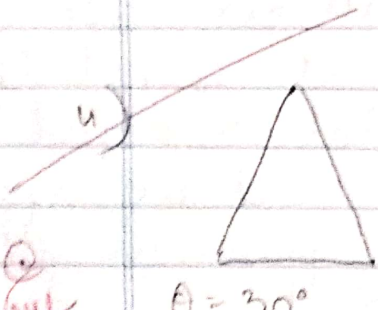
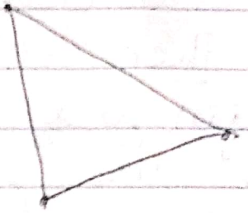
For clockwise rotation

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

Rotation about arbitrary point :- If we want to rotate an object or point about an arbitrary point first of all we translate the point about which want to rotate to the origin. Then rotate point or object about the origin and at the end we again translate it to the original place. We get rotation about an arbitrary point.

$$R_a = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -x_a & -y_a & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ x_a & y_a & -1 \end{bmatrix}$$

Testcase

Testcase	Expected	Outcome
1)  $T_x = 2$ $T_y = 0$		As expected.
2) $\theta = 30°$		As expected.
3)  $S_x = 2$ $S_y = 2$		As expected.
4)  $\theta = 30°$		As expected

Conclusion: we successfully implemented transformations on a 2D object.