SNS COLLEGE OF ENGINEERING

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Department of Information Technology

Computer Graphics

Unit 2 : TRANSFORMATIONS - ROTATION

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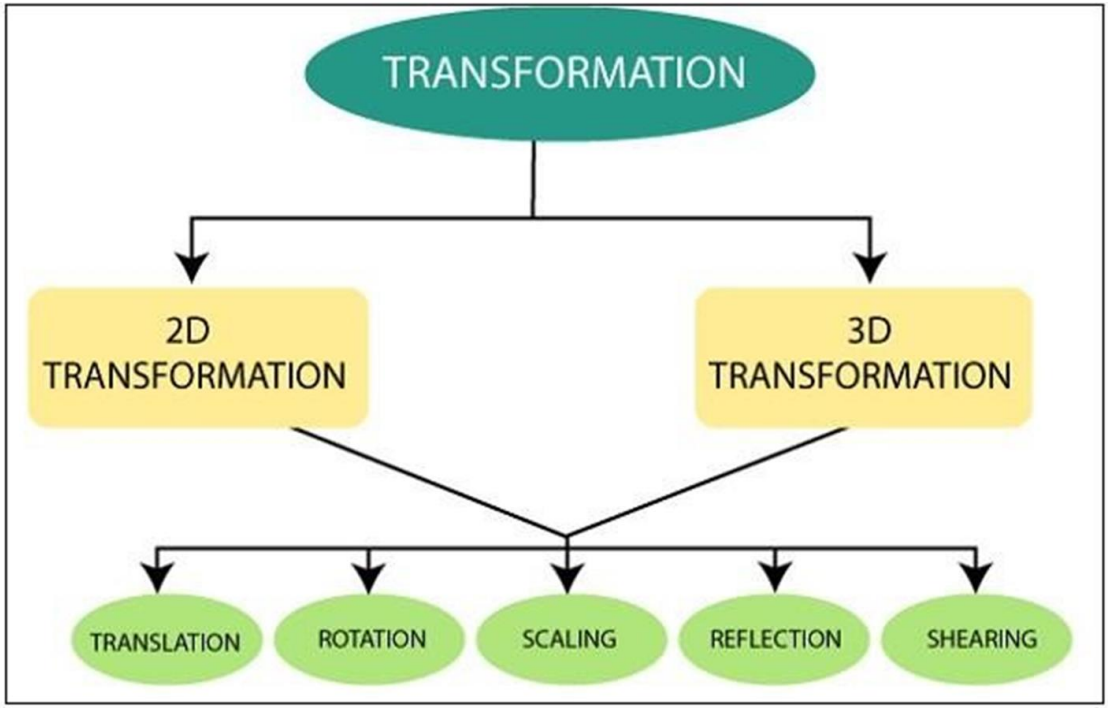
Transformation

- In computer graphics, transformation refers to the process of changing the position, size, or orientation of an object.
- It is used to manipulate and animate objects in a virtual environment.



ROTATION

2D Rotation is a process of rotating an object with respect to an angle in a two-dimensional plane.

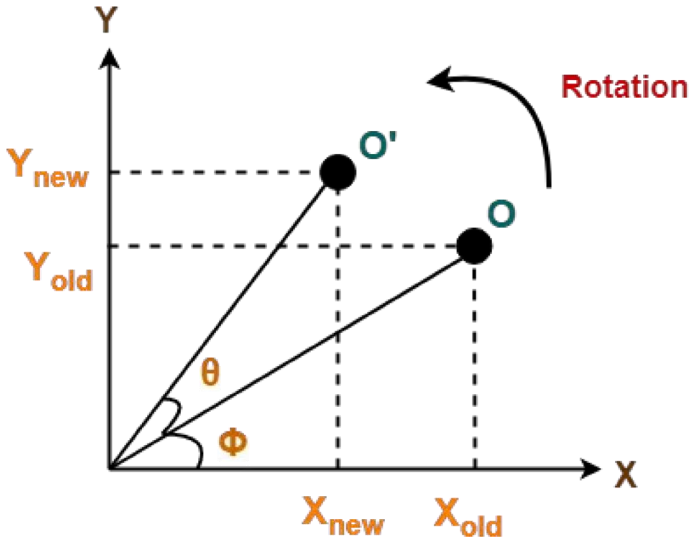
Let

Initial coordinates of the object O = (Xold, Yold)

Initial angle of the object O with respect to origin = Φ

Rotation angle = θ

New coordinates of the object O after rotation = (Xnew, Ynew)



This rotation is achieved by using the following rotation equations

$X_{new} = X_{old} \times \cos\theta - Y_{old} \times \sin\theta$

$Y_{new} = X_{old} \times \sin\theta + Y_{old} \times \cos\theta$

In Matrix form, the above rotation equations may be represented as-

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \times \begin{bmatrix} X_{old} \\ Y_{old} \end{bmatrix}$$

Problem:

Given a line segment with starting point as (0, 0) and ending point as (4, 4). Apply 30 degree rotation anticlockwise direction on the line segment and find out the new coordinates of the line.

Solution :

We rotate a straight line by its end points with the same angle. Then, we re-draw a line between the new end points.

Old ending coordinates of the line = (Xold, Yold) = (4, 4)

Rotation angle = $\theta = 30^{o}$

Let new ending coordinates of the line after rotation = (Xnew,Ynew).

Xnew

$= Xold \times \cos\theta - Yold \times \sin\theta$

$= 4 \times \cos 30^{o} - 4 \times \sin 30^{o}$

$= 4 \times (\sqrt{3} / 2) - 4 \times (1 / 2)$

$= 2\sqrt{3} - 2$

$= 2(\sqrt{3} - 1)$

$= 2(1.73 - 1)$

$= 1.46$

Ynew

$= Xold \times \sin\theta + Yold \times \cos\theta$

$= 4 \times \sin 30^{o} + 4 \times \cos 30^{o}$

$= 4 \times (1 / 2) + 4 \times (\sqrt{3} / 2)$

$= 2 + 2\sqrt{3}$

$= 2(1 + \sqrt{3})$

$= 2(1 + 1.73)$

$= 5.46$

Thus, New ending coordinates of the line after rotation = (1.46, 5.46).

In matrix form, the new ending coordinates of the line after rotation may be obtained as-

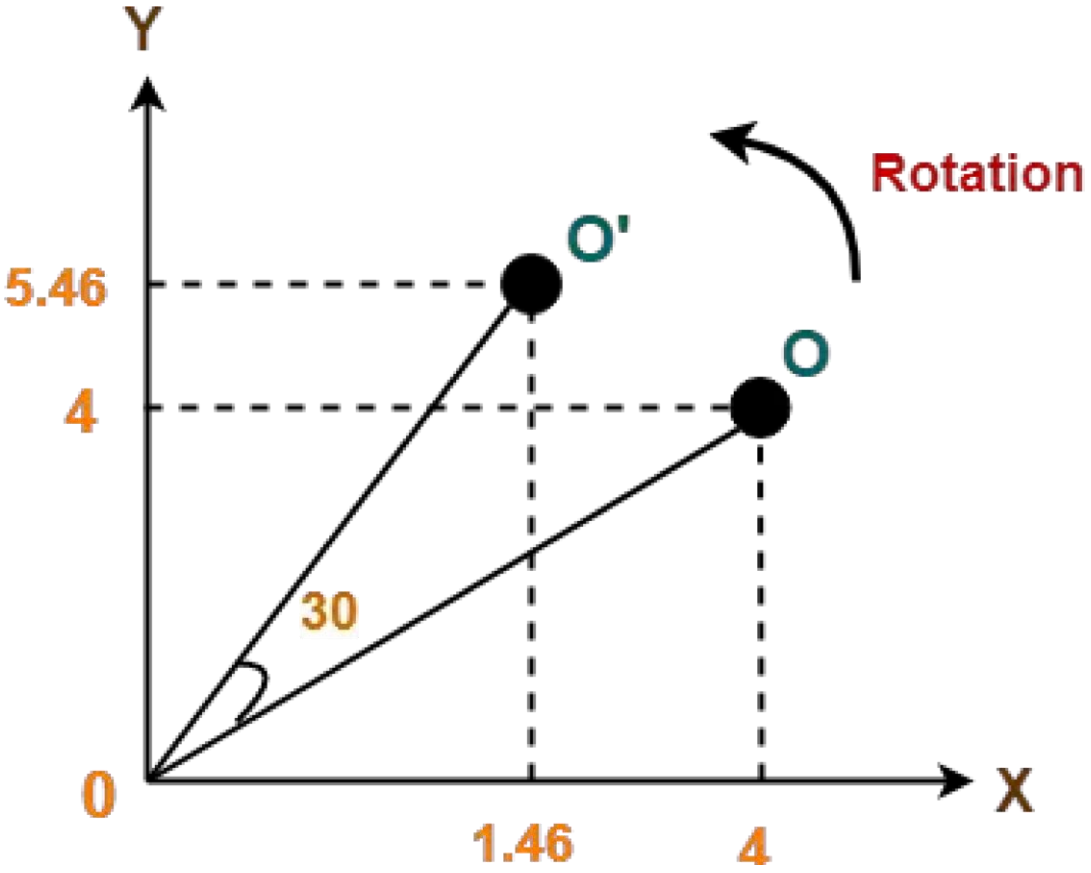
$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \times \begin{bmatrix} X_{old} \\ Y_{old} \end{bmatrix}$$

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} \cos 30 & -\sin 30 \\ \sin 30 & \cos 30 \end{bmatrix} \times \begin{bmatrix} 4 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} 4 \times \cos 30 - 4 \times \sin 30 \\ 4 \times \sin 30 + 4 \times \cos 30 \end{bmatrix}$$

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} 4 \times \cos 30 - 4 \times \sin 30 \\ 4 \times \sin 30 + 4 \times \cos 30 \end{bmatrix}$$

$$\begin{bmatrix} X_{new} \\ Y_{new} \end{bmatrix} = \begin{bmatrix} 1.46 \\ 5.46 \end{bmatrix}$$


Y
Rotation
O'
5.46
O
4
30
0
X
1.46
4