

Subject: Computer graphics

Topic : Translation, rotation, scaling

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COMPUTER GRAPHICS

MODULE 3

Topics:

Translation

Scaling

rotation

2D transformations

- Transform=change some attributes/primitives of graphic objects
- changes can be in size, shape, orientation...

Basic Transformations

- Translation (change in position - linear)
- Rotation (change in orientation - circular)
- Scaling (change in size)

Other Transformations...

- Reflection (mirror image)
- Shearing (distortion)

Translation (change in position)

- Rigid body transformation
- movement of the object from one point to another
- specify the (Tx, Ty)
[translation factor or translation vector or shift vector]

- Point (x,y) , translation vector (Tx,Ty)

$$\text{new values } x' = x + Tx$$

$$y' = y + Ty$$

- In general if we have point P , by applying translation

$$\text{new value of } P \text{ as } P' = P + T$$

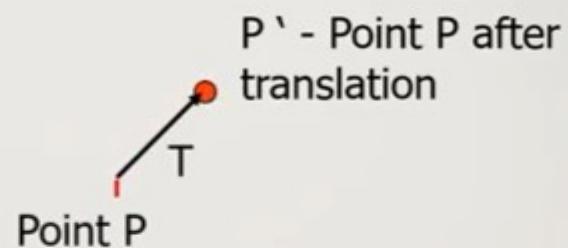
MATRIX REPRESENTATION

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} T_x \\ T_y \end{bmatrix}$$

Translating of a Point P



Translating of a Point P



Scaling (changing size of the object)

- supply the scaling factor (S_x, S_y)
- Point (x, y) & Scaling factor (S_x, S_y)

new values $x' = x * S_x$

$y' = y * S_y$

- S_x, S_y takes +ve values only
- $(S_x, S_y) > 1$ enlarge the object size
- $(S_x, S_y) < 1$ reduce the object size

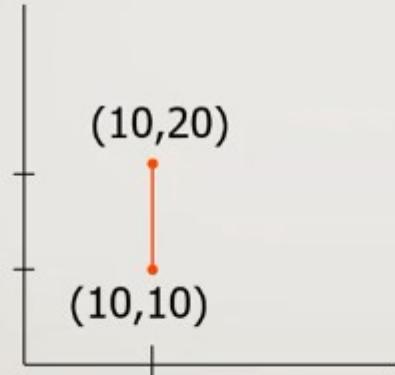
Scaling

- Uniform Scaling ($S_x = S_y$)
- Differential Scaling ($S_x \neq S_y$)

MATRIX REPRESENTATION

- $P' = P * S$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix} * \begin{bmatrix} Sx & 0 \\ 0 & Sy \end{bmatrix}$$



$$\begin{aligned}x' &= x * S_x \\y' &= y * S_y\end{aligned}$$

Eg:

$$S_x = 2$$

$$S_y = 2$$

$$1^{\text{st}} \text{ Point } 10 * 2 = 20$$

$$10 * 2 = 20$$

$$(20,20)$$

$$2^{\text{nd}} \text{ Point } 20 * 2 = 40$$

$$20 * 2 = 40$$

$$(20,40)$$



while scaling not only
the object is scaled but
also its distance from
origin is changed

meaning a translation

To avoid this specify a
fixed point (X_f, Y_f)

Scaling wrt a fixed point (Xf,Yf)

$$x' = X_f + (x - X_f) * S_x$$

$$y' = Y_f + (y - Y_f) * S_y$$

$$S_x = 2$$

$$S_y = 2$$

1st Point (10,10)

$$10 + (10 - 10) * 2 = 10$$

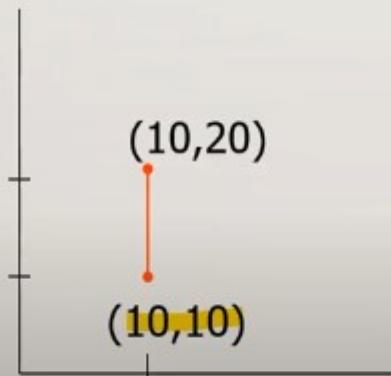
$$10 + (10 - 10) * 2 = 10$$

2nd Point(20,20)

$$10 + (10 - 10) * 2 = 10$$

$$10 + (20 - 10) * 2 = 30$$

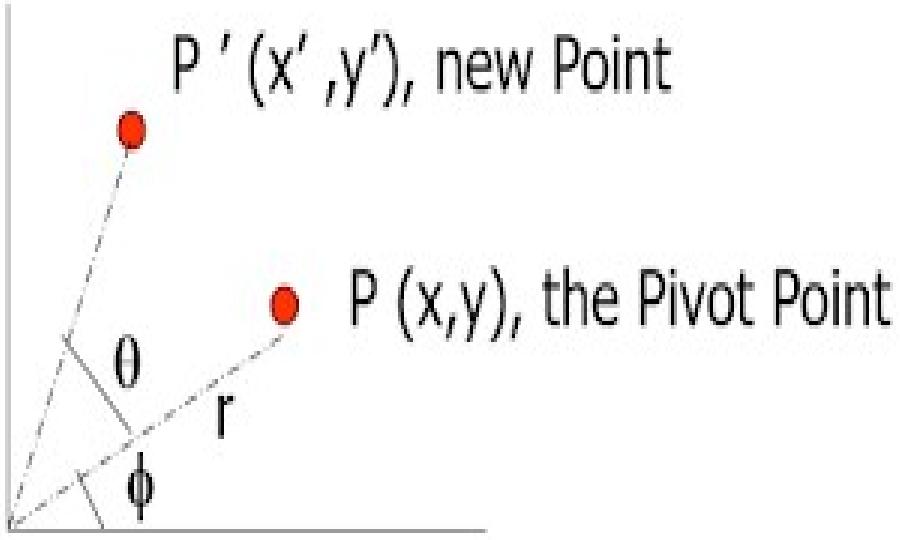
$$(10,30)$$

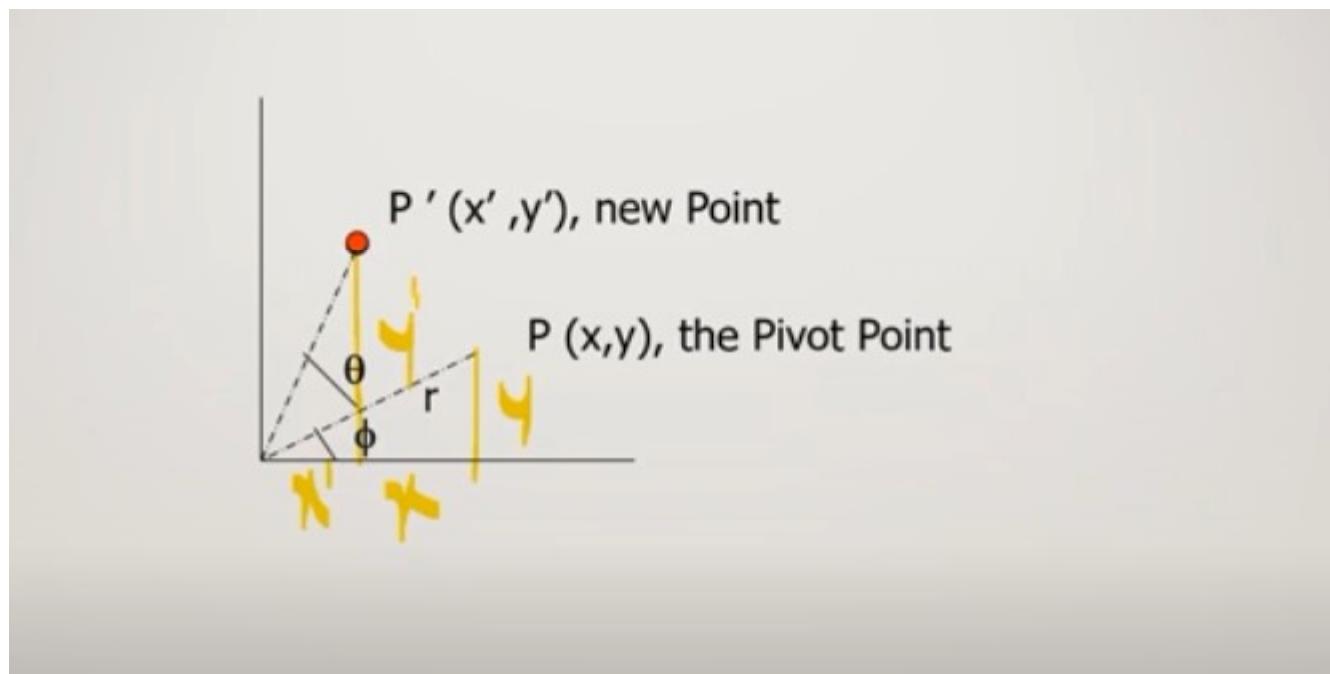


Rotation (Change in orientation)

- Transforming the object points along a circular path
- It is a rigid body transformation
- defining parameter is θ
 - +ve value means anti-clockwise rotation
 - ve value means clockwise rotation

pivot point – a point about which the object is rotated





Rotation wrt origin (0,0)

Using trigonometric eqns

$$x' = r \cos(\phi + \theta) = r \cos \phi \cos \theta - r \sin \phi \sin \theta$$

$$y' = r \sin(\phi + \theta) = r \sin \phi \cos \theta + r \cos \phi \sin \theta$$

Polar coordinates of Point (x,y)

$$x = r \cos \phi \text{ and } y = r \sin \phi$$

Sub the values

$$\mathbf{x'} = x \cos \theta - y \sin \theta$$

$$\mathbf{y'} = x \sin \theta + y \cos \theta$$

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

Matrix representation

$$P' = P * R(\theta)$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix} * \begin{bmatrix} x \\ y \end{bmatrix}$$

Rotation wrt a Fixed Point (X_r, Y_r)

$$x' = X_r + (x - X_r) \cos \theta - (y - Y_r) \sin \theta$$

$$y' = Y_r + (x - X_r) \sin \theta + (y - Y_r) \cos \theta$$

Point (x', y')



Point (x, y)

Fixed Point (X_r, Y_r)