Computer Graphics

Week 2

Lecture 2

2D Transformations

Graphics Systems Basics:

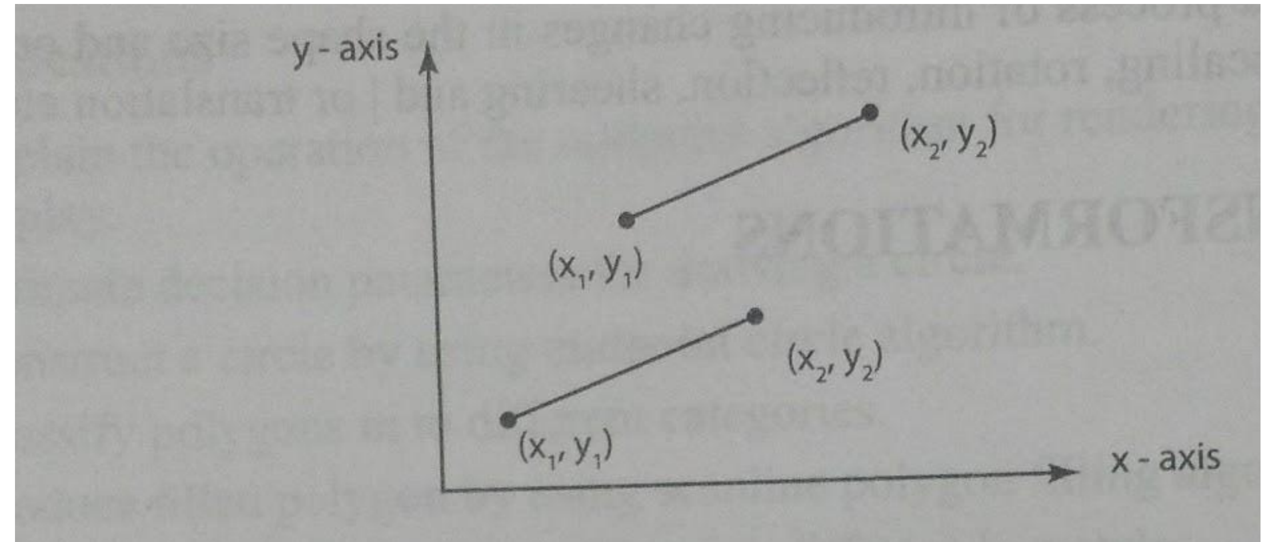
- Simulate Movement
- Manipulate Objects in a plane

Transformations help manipulate Size and orientation of object in plane

Basic Transformations

- Translation
- Rotation
- Scaling

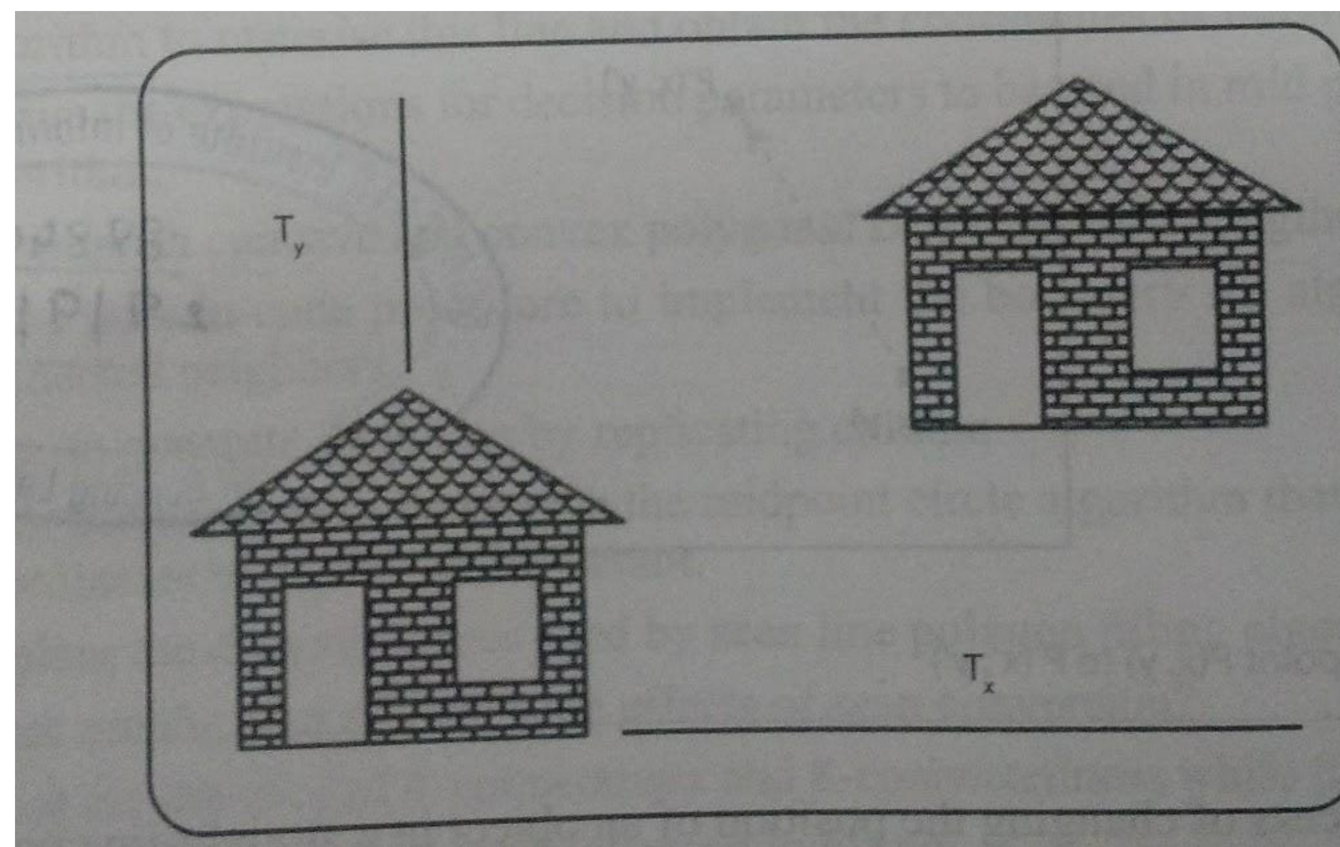
Translation



Translation of a line

Moving object from one place to another [PIC]

$$x' = x + T_x$$
$$y' = y + T_y$$

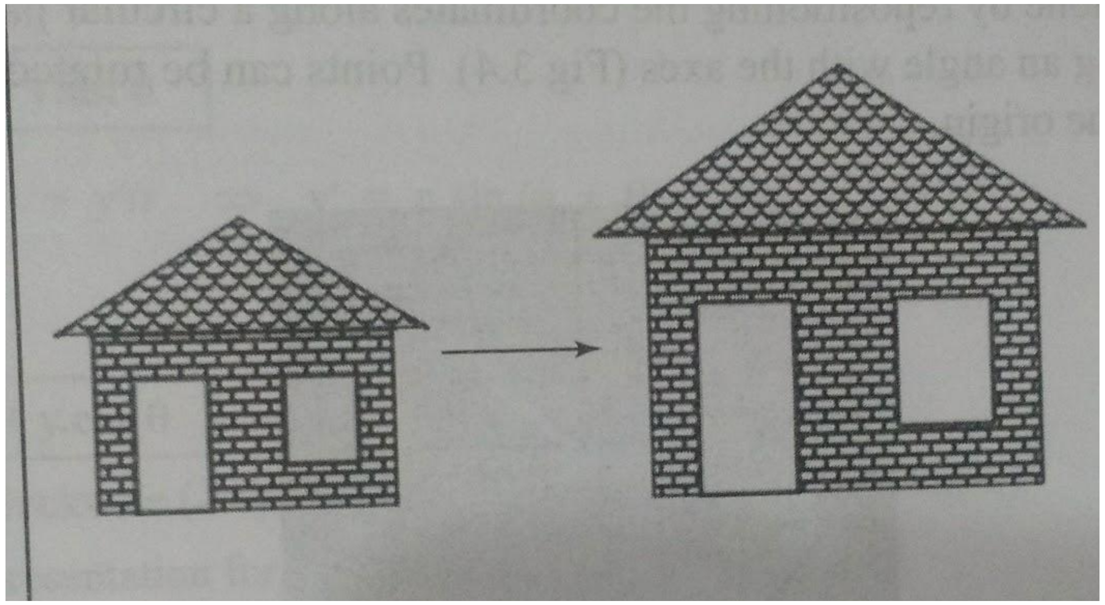


Translate the house by translation factor Tx and Ty

Scaling(about origin)

Expanding or Compressing an object

$x' = x \cdot S_x$
$y' = y \cdot S_y$



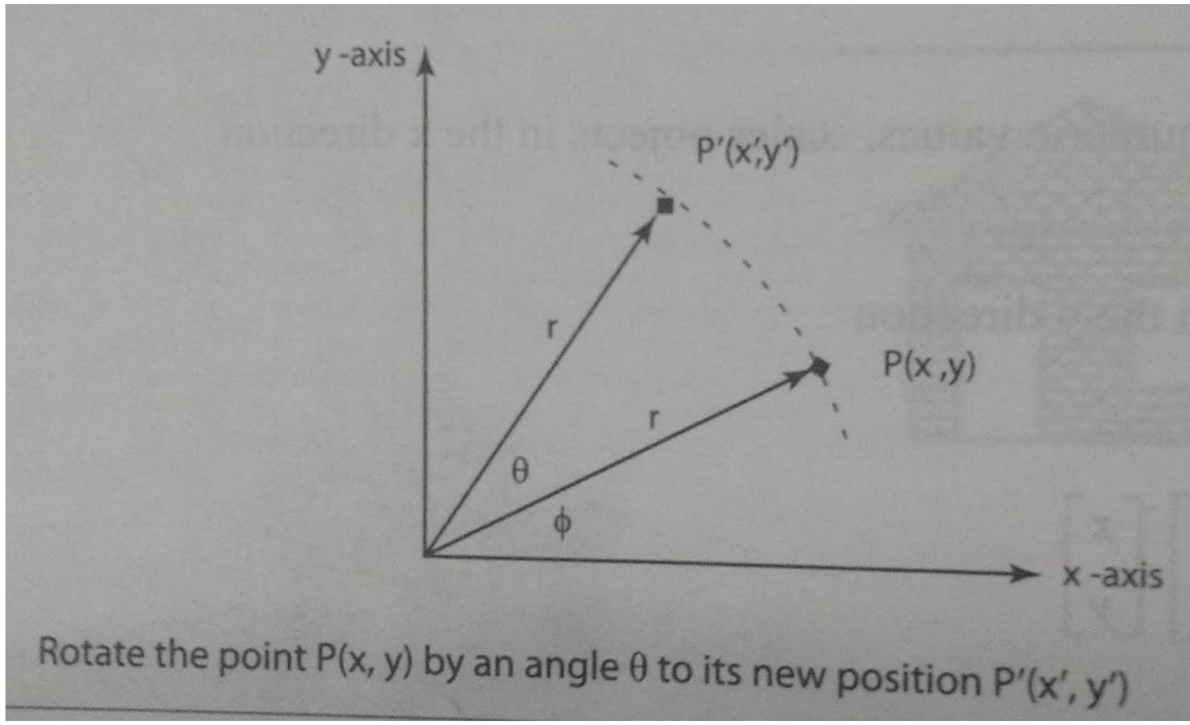
- If both Sx and Sy are > 1 → Size of object increases
- If both Sx and Sy are < 1 → Size of object decreases

- scaling factors > 1 object moves farther from origin
- scaling factors < 1 object moves nearer to origin

Rotation(about origin)

Moving an object along a circular path

$x' = x.\cos\theta - y.\sin\theta$
$y' = x.\sin\theta + y.\cos\theta$
(anticlockwise rotation about origin)



Matrix Representation

Translation:

$x' = x + T_x \rightarrow$

$y' = y + T_y$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} Tx \\ Ty \end{bmatrix}$$

Scaling:

$x' = x \, . \, S_x \rightarrow$

$y' = y \, . \, S_y$

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

Rotation:

$x' = x.\cos\theta - y.\sin\theta \rightarrow$

$y' = x.\sin\theta + y.\cos\theta$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} Cos\,\theta & -Sin\,\theta \\ Sin\,\theta & Cos\,\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Homogeneous Coordinates

Converting the 2x2 matrix transformations into 3x3 matrix transformations

- We get a more consistent format of representing transformations
- More useful for compound transformations

Homogenous Coordinates

Translation:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & Tx \\ 0 & 1 & Ty \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Scaling:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Rotation:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} Cos\,\theta & -Sin\,\theta & 0 \\ Sin\,\theta & Cos\,\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

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–Johnny Appleseed