



# Computer Graphics

*Week 2*  
*Lecture 2*



# *2D Transformations*

The background of the slide features a close-up, artistic photograph of several interlocking metal gears. The gears are of various sizes and are arranged in a way that creates a sense of depth and mechanical complexity. The lighting highlights the metallic texture and the sharp teeth of the gears. A large, semi-transparent brown rectangle is overlaid on the right side of the image, serving as a background for the text.

## Graphics Systems Basics:

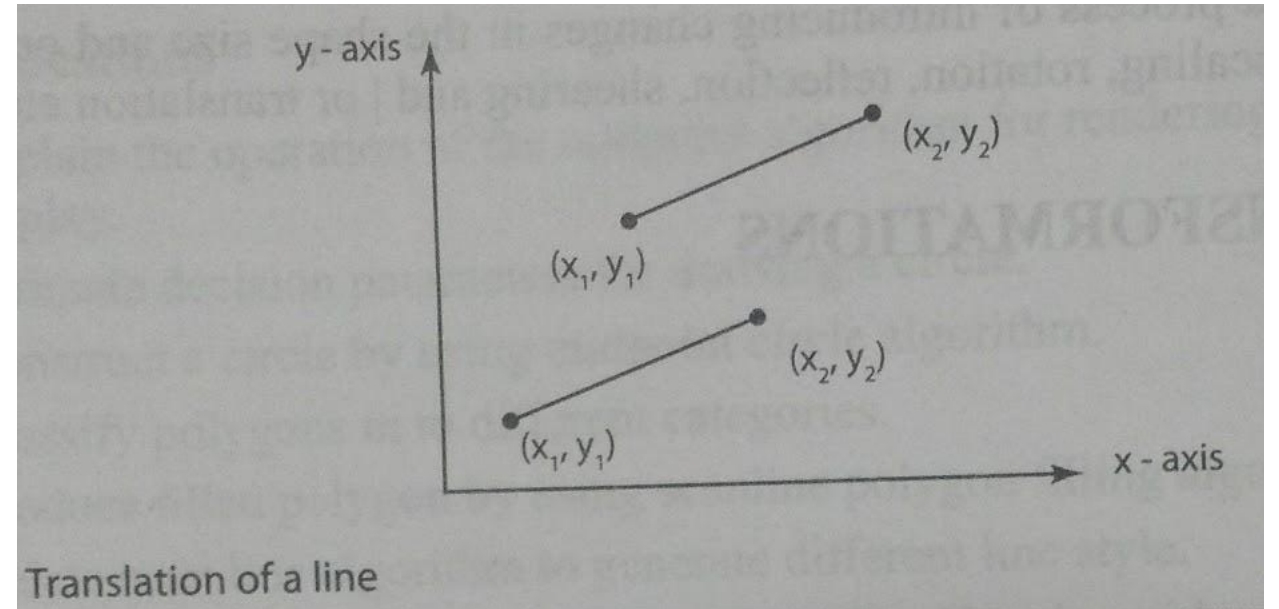
- Simulate Movement
- Manipulate Objects in a plane

Transformations help manipulate Size and orientation of object in plane

# Basic Transformations

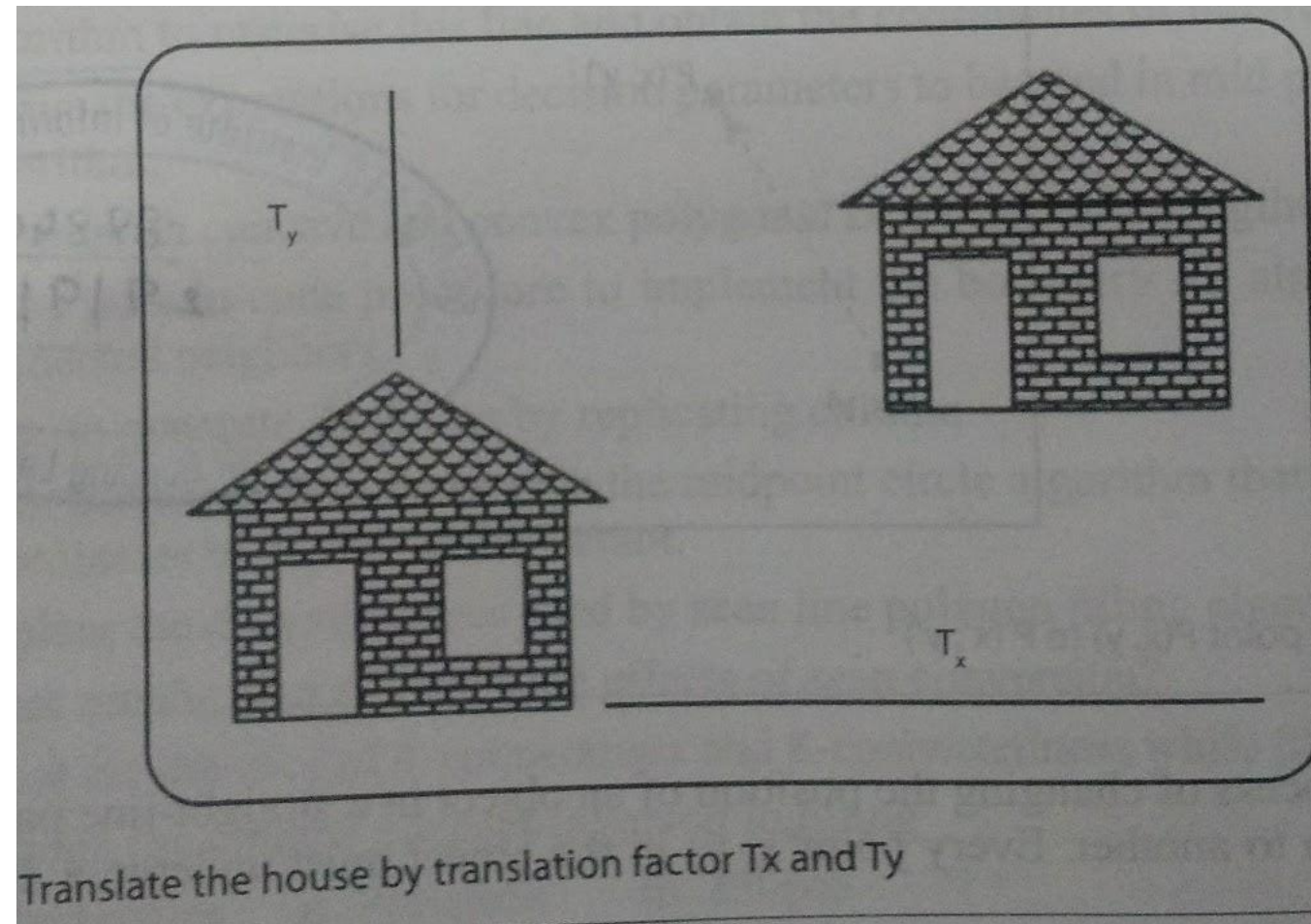
- Translation
- Rotation
- Scaling

# Translation



Moving object from one place to another [PIC]

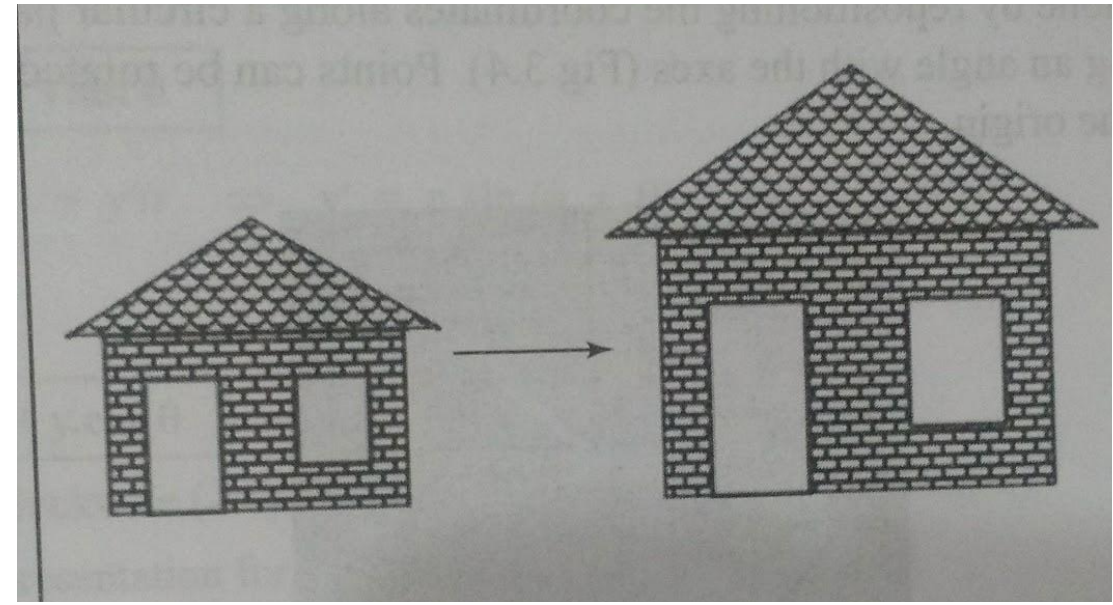
$$x' = x + T_x$$
$$y' = y + T_y$$



# Scaling(about origin)

Expanding or Compressing an object

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



- If both  $S_x$  and  $S_y$  are  $> 1 \rightarrow$  Size of object increases
- If both  $S_x$  and  $S_y$  are  $< 1 \rightarrow$  Size of object decreases
- scaling factors  $> 1$  object moves farther from origin
- scaling factors  $< 1$  object moves nearer to origin



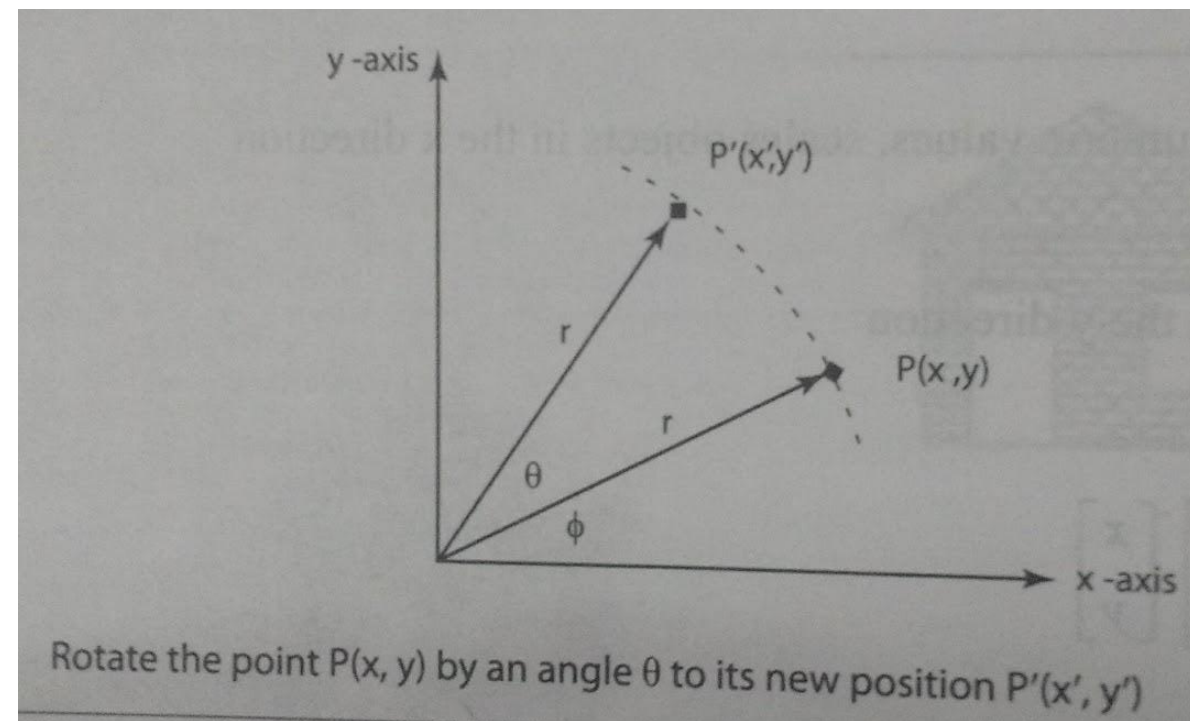
# Rotation(about origin)

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:

$$\begin{aligned}x' &= x + T_x \rightarrow \\y' &= y + T_y\end{aligned}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} T_x \\ T_y \end{bmatrix}$$

Scaling:

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

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Rotation:

$$\begin{aligned}x' &= x \cdot \cos \theta - y \cdot \sin \theta \rightarrow \\y' &= x \cdot \sin \theta + y \cdot \cos \theta\end{aligned}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$



# Homogeneous Coordinates

Converting the  $2 \times 2$  matrix transformations into  $3 \times 3$  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:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

*The End*





The image features a decorative background of interlocking gears. The gears are primarily golden-brown with some silver-colored ones, set against a white background. They are arranged in a pattern that suggests a complex mechanical system. A large, solid tan-colored rectangle is positioned on the right side of the image, partially obscuring the gear pattern.

Text

TEX  
T

[TEXT]



Text

Text

