

Computer Graphics

LECTURE 16

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Last Class

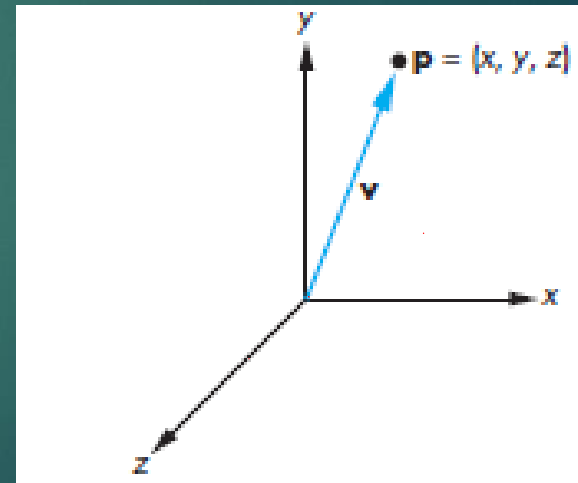
- ▶ Homogeneous transformations
- ▶ Types of Transformations
 - ▶ Linear Transformations
 - ▶ Affine Transformations
 - ▶ Projective Transformations
- ▶ Combining Homogeneous transformations

Today's Agenda

- ▶ 3D Transforms
- ▶ Inverse Rotation
- ▶ Clipping

3D Transforms

- ▶ The idea of 3D transforms is the same as that of 2D
 - ▶ A 3D point is represented by (x, y, z)
 - ▶ Homogeneous Coordinates are defined as
 - ▶ A 4th Coordinate is added to every 3D point
 - ▶ (x, y, z, t) represents $(x/t, y/t, z/t)$
 - ▶ $(x, y, z, 0)$ represents infinity
 - ▶ $(0, 0, 0, 0)$ is not allowed



General 3D Homogeneous Transform

$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Scaling

► Scaling matrix

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} a & 0 & 0 & 0 \\ 0 & b & 0 & 0 \\ 0 & 0 & c & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Translation

► Translation matrix

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & a \\ 0 & 1 & 0 & b \\ 0 & 0 & 1 & c \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Reflection

- ▶ Reflection Matrix about yz – plane

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

- ▶ What are other reflection matrices

Rotation

- Rotation about Z – axis

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

Rotation

- Rotation about Y – axis

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

Rotation

- Rotation about X – axis

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

Summary

- ▶ 3D Transforms
- ▶ Inverse Rotation
- ▶ Clipping

References

- ▶ Fundamentals of Computer Graphics Third Edition by Peter Shirley and Steve Marschner
- ▶ Interactive Computer Graphics, A Top-down Approach with OpenGL (Sixth Edition) by Edward Angel.