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Subject: Computer graphics

Unit: IV

Topic: 3 D Transformation

## 3 D SHEARING TRANSFORMATION

3D Shearing transformation is a technique to change the shape of an existing object in a three dimensional plane.

In a three dimensional plane, the object shape can be changed along X direction, Y direction as well as Z direction.

So, there are three versions of shearing-

- Shearing in X direction
- Shearing in Y direction
- Shearing in Z direction

### Shearing in X direction

#### Mathematical Description:

Consider a point object P has to be sheared in a 3D plane. The initial coordinates of the object P is  $(X_1, Y_1, Z_1)$  and new coordinates of object P' after shearing is  $(X_2, Y_2, Z_2)$ . Let shearing factor towards X direction is  $Sh_x$ , shearing factor towards Y direction is  $Sh_y$  and shearing factor towards Z direction is  $Sh_z$ .

Shearing in X axis is achieved by using the following shearing equations-

$$X_2 = X_1$$

$$Y_2 = Y_1 + Sh_y * X_1$$

$$Z_2 = Z_1 + Sh_z * X_1$$

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

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ Sh_y & 1 & 0 & 0 \\ Sh_z & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \\ 1 \end{bmatrix}$$

This is shearing transformation matrix in X direction

### Shearing in Y direction

Shearing in Y axis is achieved by using the following shearing equations-

$$X_2 = X_1 + Sh_x * Y_1$$

$$Y_2 = Y_1$$

$$Z_2 = Z_1 + Sh_z * Y_1$$

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

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & Sh_x & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & Sh_z & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \\ 1 \end{bmatrix}$$

This is shearing transformation matrix in Y direction

### Shearing in Z direction

Shearing in Z axis is achieved by using the following shearing equations-

$$X_2 = X_1 + Sh_x * Z_1$$

$$Y_2 = Y_1 + Sh_y * Z_1$$

$$Z_2 = Z_1$$

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

$$\begin{bmatrix} X_2 \\ Y_2 \\ Z_2 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & Sh_x & 0 \\ 0 & 1 & Sh_y & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} X_1 \\ Y_1 \\ Z_1 \\ 1 \end{bmatrix}$$

This is shearing transformation matrix in Z direction

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