FACULTY OF ENGINEERING & TECHNOLOGY

BCS -504 Computer Graphics & Multimedia

Lecture-12

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- **MATRIX REPRESENTATION OF 2D TRANSFORMATION**

- **HOMOGENEOUS COORDINATES**

- **MATRIX FOR TWO-DIMENSIONAL TRANSFORMATION IN HOMOGENEOUS COORDINATE**

- **COMPUTER GRAPHICS WINDOW**

Matrix Representation of 2D Transformation

1. Scaling $\begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$

2. Rotation (clockwise) $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$

3. Rotation (anti-clock) $\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$

4. Translation $\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ t_x & t_y \end{bmatrix}$

5. Reflection $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

(about x axis)

6. Reflection $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

(about y axis)

7. Reflection $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

(about origin)

8. Reflection about Y=X $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

9. Reflection about Y= −X $\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$

10. Shearing in X direction $\begin{bmatrix} 1 & 0 \\ Sh_x & 1 \end{bmatrix}$

11. Shearing in Y direction $\begin{bmatrix} 1 & Sh_y \\ 0 & 1 \end{bmatrix}$

12. Shearing in both x and y direction $\begin{bmatrix} 1 & Sh_y \\ Sh_x & 1 \end{bmatrix}$

Homogeneous Coordinates

The rotation of a point, straight line or an entire image on the screen, about a point other than origin, is achieved by first moving the image until the point of rotation occupies the origin, then performing rotation, then finally moving the image to its original position.

The moving of an image from one place to another in a straight line is called a translation. A translation may be done by adding or subtracting to each point, the amount, by which picture is required to be shifted.

Translation of point by the change of coordinate cannot be combined with other transformation by using simple matrix application. Such a combination is essential if we wish to rotate an image about a point other than origin by translation, rotation again translation

Homogeneous Coordinates

To combine these three transformations into a single transformation, homogeneous coordinates are used. In

homogeneous coordinate system, two-dimensional coordinate positions (x, y) are represented by triple-coordinates.

Homogeneous coordinates are generally used in design and construction applications. Here we perform translations,

rotations, scaling to fit the picture into proper position.
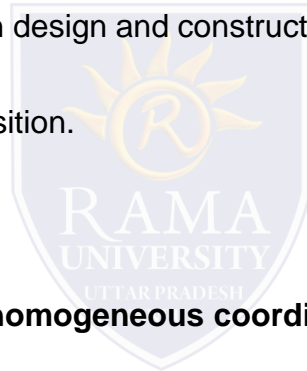
Example of representing coordinates into a homogeneous coordinate system: For two-dimensional geometric

transformation, we can choose homogeneous parameter h to any non-zero value. For our convenience take it as one.

Each two-dimensional position is then represented with homogeneous coordinates (x, y, 1).

Following are matrix for two-dimensional transformation in homogeneous coordinate

1. Translation

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 1 \end{bmatrix} \text{ or } \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

2. Scaling

$$\begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

3. Rotation (clockwise)

$$\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

4. Rotation (anti-clock)

$$\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

5. Reflection against X axis

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

6. Reflection against Y axis

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

7. Reflection against origin

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

8. Reflection against line Y=X

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

9. Reflection against Y= −X

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

10. Shearing in X direction

$$\begin{bmatrix} 1 & 0 & 0 \\ Sh_x & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

11. Shearing in Y direction

$$\begin{bmatrix} 1 & Sh_y & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

12. Shearing in both x and y direction

$$\begin{bmatrix} 1 & Sh_y & 0 \\ Sh_x & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Computer Graphics Window

The method of selecting and enlarging a portion of a drawing is called windowing. The area chosen for this display is called a window. The window is selected by world-coordinate.

Sometimes we are interested in some portion of the object and not in full object. So we will decide on an imaginary box. This box will enclose desired or interested area of the object. Such an imaginary box is called a window.

Viewport: An area on display device to which a window is mapped [where it is to displayed].

Basically, the window is an area in object space. It encloses the object. After the user selects this, space is mapped on the whole area of the viewport. Almost all 2D and 3D graphics packages provide means of defining viewport size on the screen. It is possible to determine many viewports on different areas of display and view the same object in a different angle in each viewport.

The size of the window is (0, 0) coordinate which is a bottom-left corner and toward right side until window encloses the desired area. Once the window is defined data outside the window is clipped before representing to screen coordinates. This process reduces the amount of data displaying signals.

The window size of the Tektronix 4.14 tube in Imperial College contains 4.96 points horizontally and 3072 points vertically.

Viewing transformation or window to viewport transformation or windowing transformation: The mapping of a part of a world-coordinate scene to device coordinates is referred to as a viewing transformation etc.
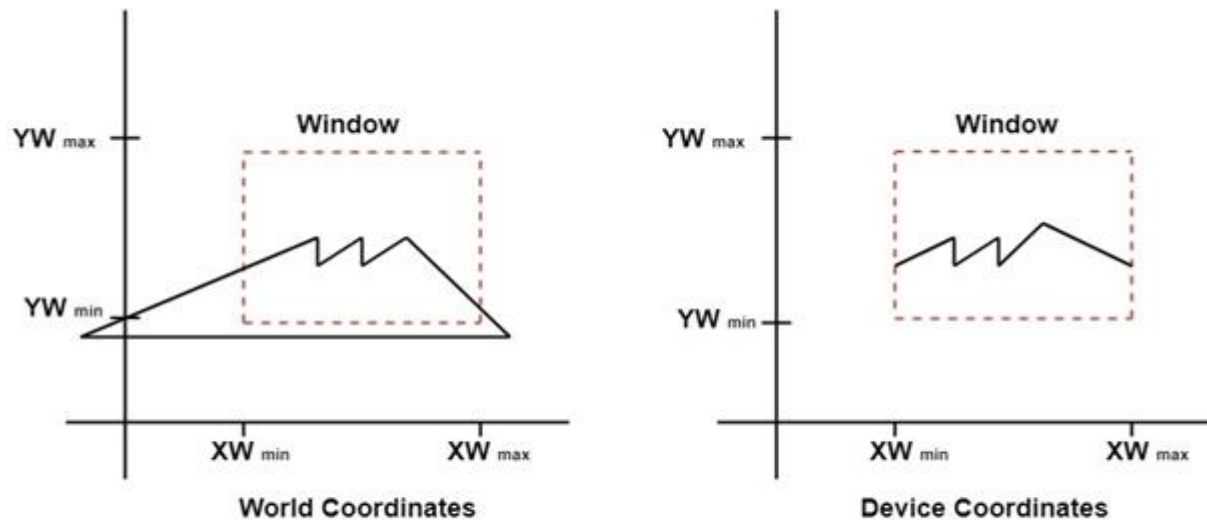

Fig: A viewing transformation using standard rectangles for the window and viewport.

MUTIPLE CHOICE QUESTIONS:

Sr no	Question	Option A	Option B	OptionC	OptionD
1	A dot triangle when activated appears as a small dot on the screen which has color of combination of……...small dots in the dot triangle	3	2	4	1
2	In raster scan display we do refreshing of the screen to maintain a ………	screen Pixel.	screen image.	image.	quality
3	Direct-view storage tube. DVST gives alternative method for maintaining the…………….	screen image	screen Pixel.	quality	image.
4	What DVST will stores ?	quality information	image information	picture information	b & c
5	DVST consists……….. electron guns a primary gun and a flood gun	2	3	4	1

- http://www.engppt.com/search/label/Computer%20Graphics