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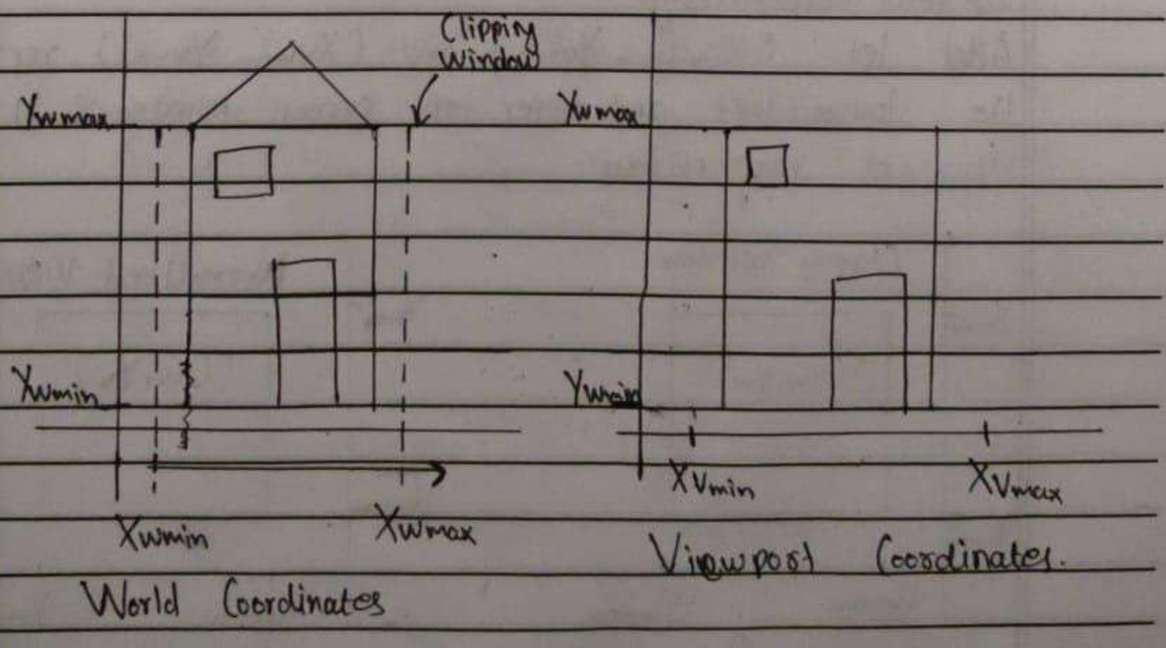
Assignment-2

Q1. Derive the window to viewport transformation and explain what is window and viewport.

Window - This visible region of the scene inside the clipping window is displayed on some device. More formally, the world coordinate area which is selected for display is called a window.

Viewport → An area on the display device to which window is mapped is called viewport.

Window defines what is to be displayed from the scene and viewport defines where it is to be displayed on the screen.

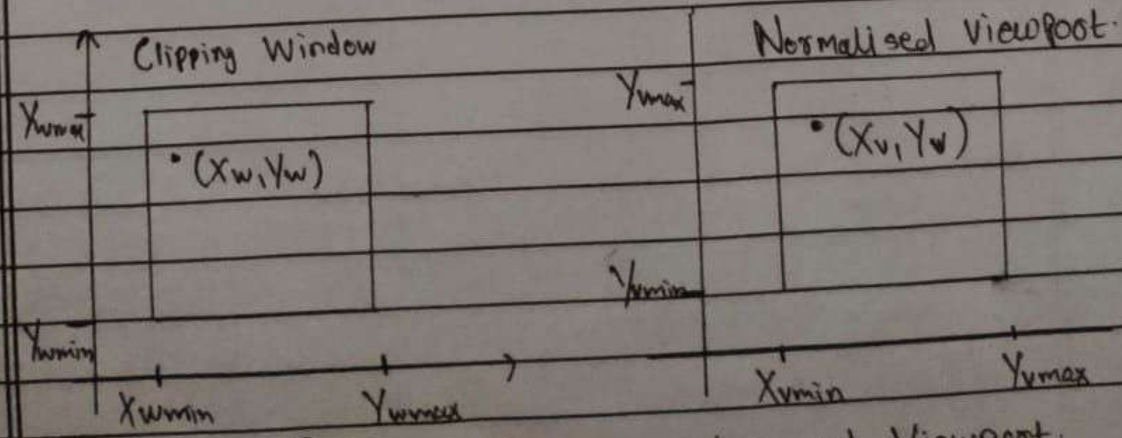


Here, X_w, Y_w are well coordinates.
and X_v, Y_v are viewport coordinates.

Window to viewport transformation →
The process of mapping the part of world coordinate ~~sten~~ source to device coordinate is referred to as a viewing transformation or window to view port ~~transpo~~ transformation or windowing transformation.

Window to the viewport to transformation is necessary because the size of the window and viewport may not be the same all the time. So actual scene selected by window needs to be rescaled to fit in the viewport.

Let (X_{wmin}, Y_{wmin}) and (X_{wmax}, Y_{wmax}) represent the lower left and upper-top corner points of clipping window respectively.
And let (X_{vmin}, Y_{vmin}) and (X_{vmax}, Y_{vmax}) represent the lower left and upper top corner points of the viewport respectively.



Relation between window and Viewport.

As shown in figure, point (X_w, Y_w) in the window is to be mapped to point (X_v, Y_v) in the viewport. To maintain the same relative placement in the viewport as in a window, we normalize both. So,

$$\frac{X_v - X_{vmin}}{X_{vmax} - V_{vmin}} = \frac{X_w - X_{wmin}}{X_{wmax} - X_{wmin}}$$

$$\therefore X_v - X_{vmin} = (X_{vmax} - X_{vmin}) \frac{(X_w - X_{wmin})}{(X_{wmax} - X_{wmin})}$$

$$\therefore X_v = X_{vmin} + (X_w - X_{wmin}) \cdot S_x$$

where S_x is scaling factor.

$$S_x = \left(\frac{X_{vmax} - X_{vmin}}{X_{wmax} - X_{wmin}}\right)$$

Similarly,

$$\frac{Y_v - Y_{wmin}}{Y_{vmax} - Y_{vmin}} = \frac{Y_w - Y_{wmin}}{Y_{wmax} - Y_{wmin}}$$

$$\therefore Y_v - Y_{vmin} = (Y_{vmax} - Y_{wmin}) \frac{(Y_w - Y_{wmin})}{(Y_{wmax} - Y_{wmin})}$$

$$\therefore Y_v = Y_{vmin} + (Y_w - Y_{wmin}) \cdot S_y$$

where the S_y is scaling factor,

$$S_y = \frac{(Y_{vmax} - Y_{wmin})}{(Y_{wmax} - Y_{wmin})}$$

Matrix Representation →

If the lower-left corner of the window is not at the origin, we should first translate it to the origin before we map the point in the window to the viewport.

To achieve this we have to follow certain step ie.

$$M = T^{-1} \cdot S \cdot T$$

$$T = \begin{bmatrix} 0 & 0 & -X_{wmin} \\ 0 & 0 & -Y_{wmin} \\ 0 & 0 & 1 \end{bmatrix}$$

$$S = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad T^{-1} = \begin{bmatrix} 0 & 0 & X_{vmin} \\ 0 & 0 & Y_{vmin} \\ 0 & 0 & 1 \end{bmatrix}$$

$$M = \begin{bmatrix} 0 & 0 & X_{vmin} \\ 0 & 0 & Y_{vmin} \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{X_{vmax}-X_{vmin}}{X_{wmax}-X_{wmin}} & 0 & 0 \\ 0 & \frac{Y_{vmax}-Y_{vmin}}{Y_{wmax}-Y_{wmin}} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & -X_{vmin} \\ 0 & 0 & -Y_{vmin} \\ 0 & 0 & 1 \end{bmatrix}$$

Q2] Differentiate between parallel and perspective projection.

Parallel Projection	Perspective Projection
• Projectors are parallel to each other.	• Projectors are not parallel.
• Need to specify the direction of projection.	• Need to specify the center of projection.
• Center of projection is at infinite distance.	• Center of projection is at a finite distance.
• Does not produce a realistic view.	• Produces realistic view.
• Depth information is lost	• Depth information is preserved.
• Preserve relative proportion of object.	• Does not preserve relative proportion of object.
• Subtypes → i) Orthographic projection ii) Oblique projection.	• Subtypes → (i) Single point Projection (ii) Two point projection (iii) Three point projection.

Q3. Give principles of animation

1) ~~Animators~~ Squash and Strech → Squash and strech define the elasticity, volume and flexibility of the character.

2) Anticipation → Anticipation prepares the viewer for the main action to come for example. starting to run, jump, kick, etc. The first step of anticipation is to squat

3) Staging → It reflects the use of stage elements, pose, camera motion and action. The presentation of an idea ~~so~~ that ~~is~~ it is unmistakably clear, focusing on what is important in the scene.

4) Straight ahead action and pose to pose → Straight head animation start with the first picture and gradualy translates to the final scene

5) Follow Through and Overlapping Action → Different parts of a body might continue moving after the main body has stopped, adding realism.

6) Slow - In and Slow Out → Adding more frames at the beginning and end of a movement to make it more natural.

7) ~~Arc → Most natural movements follow an~~

8) Secondary Action → Adding additional action to support the main action, giving the scene more life.

9) Timing → The number of frames assigned to an action defines its speed contributing to the weight, emotion and personality of the animation.

10) Exaggeration → Amplifies certain elements to make action more dynamic or comedic.

11) Solid Drawing → Good drawing skills are crucial for creating believable forms and adding volume and weight to characters.

12) Appeal → Creating engaging and charming characters, ensuring audiences want to watch them.

Q4. Give properties of Beizer Curves.

Properties of Bezier Curves→

1) Degree of the curve is one less that a number of control points.
2) Always interpolates first and last control points and approximates remaining two
3) The slop of the derivative at the beginning is along the line joining the first two points and slope of the derivative at the end is along the line joining the last two points.
4) Bezier curve always satisfies the convex hull property.
5) At any parameter value t, sum all four Bezier blending function is always 1 i.e.

$$\sum_{i=0}^{n} BEZ_{i,n}(t)=1$$

6) Polynomial smoothly follows the control points without much oscillation.
7) Bezier curves do not have local control, repositioning one control point change the entire curve.
8) The curve is invariant center affine transformation
9) The basis functions are real.
10) The curve exhibits variation diminishing property i.e. any line intersects the Beizer curve at most as often as that

line intersects the polygon interpolating control points.

11) Bezier curve can fit any number of control points.

12) Reversing the order of control points yield the same Bezier curve.