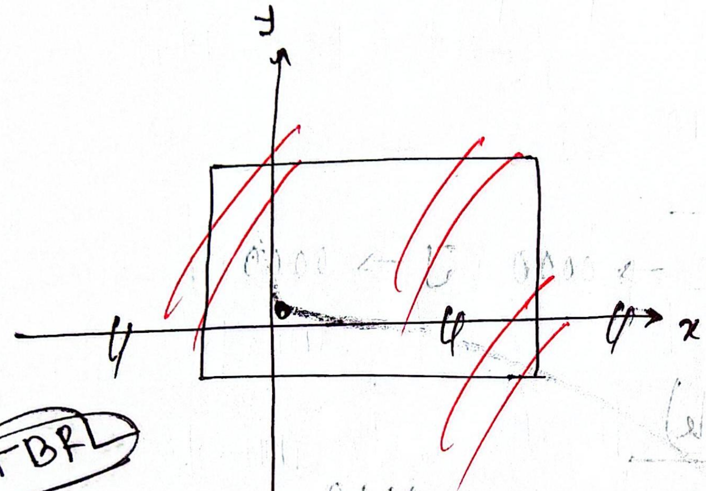
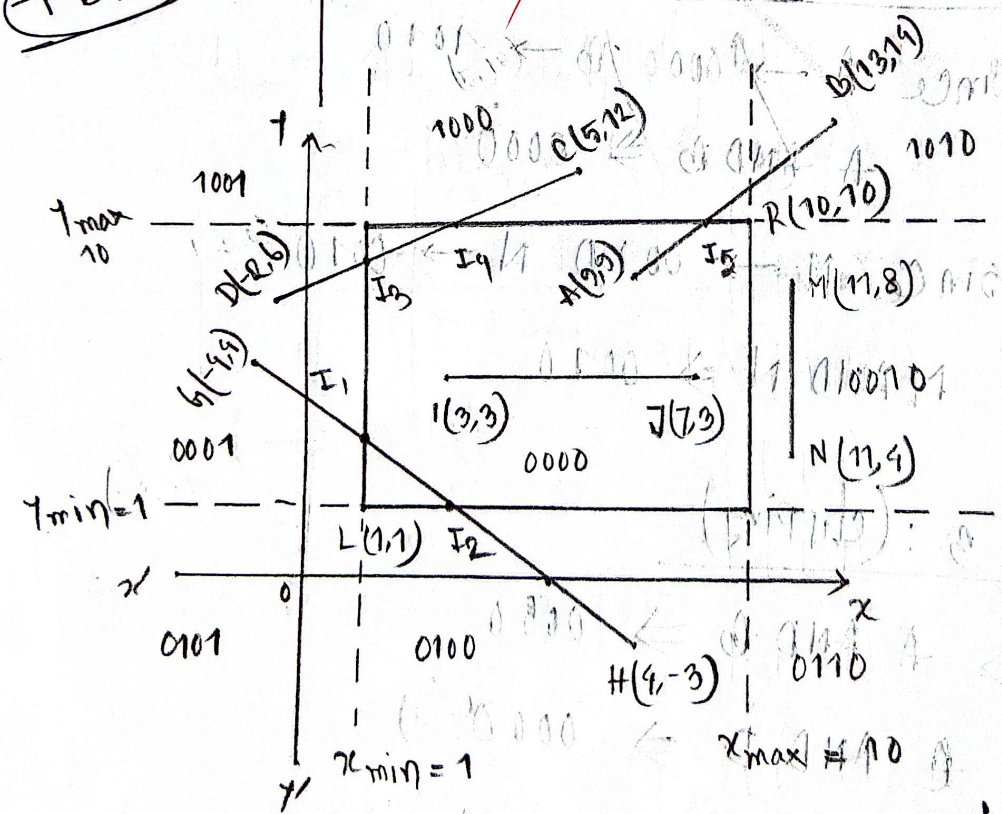
"Final Topics"

Segment - 4

1(a) | SP'23



TBRL



The region Codes are →

A → 0000 B → 1010

C → 1000 D → 0001

G → 0001 H → 0100

I → 0000

J → 0000

M → 0010

N → 0010

The line is visible if both Code are ⇒ 0000

not visible if logical AND is not 0000

Clipping if " " is 0000

Now,

Category 1: (Visible)

$\overline{IJ}$ since, I → 0000 J → 0000

Category 2: (Not Visible)

$\overline{AB}$, since A → 0000 B → 1010

A AND B ⇒ 0000

$\overline{MN}$, since M → 0010 N → 0010

M AND N ⇒ 0010

Category 3: (Clipping)

$\overline{AB}$ ⇒ A AND B ⇒ 0000

$\overline{CD}$ ⇒ A AND D ⇒ 0000

$\overrightarrow{GH}$ ⇒ G AND H ⇒ 0000

In $\overline{GH}$, for I_1 boundary line is verticle,

$x_i = x_{min} = 1$

$y_i = y_1 + m(x_i - x_1)$ $\qquad m = \frac{-3-4}{4+4} = -0.88$

$= 4 + \{-0.88 * (1+4)\}$

$= 4 - 4.38 = -0.38$

so, $I_1 = (1, -0.38)$

For, I_2 boundary line is horizontal,

$y_i = y_{min} = 1$

$x_i = x_1 + (y_i - y_1)/m$

$= -4 + \frac{1-4}{-0.88} = -0.59$

so, $I_2 = (-0.59, 1)$

In $\overline{CD}$, For I_3 boundary line is Vertical,

$x_i = x_{min} = 1$ $\qquad m = \frac{12-6}{5+2} = 0.86$

$y_i = y_1 + m(x_i - x_1)$

$= 12 + 0.86 * -4$

$= 8.57$ $\qquad$ so, $I_3 = (1, 8.57)$

For I_4, boundary line is horizontal,

$$y_i = y_{max} = 10$$

$$x_i = x_1 + (y_i - y_1)/m = 5 + (10 - 12)/0.86$$

$$= 2.67$$

So, $I_4 = (\cancel{10}, 2.67, 10)$

In $\overline{AB}$, For I_5 boundary line is horizontal

$$y_i = y_{max} = 10$$

$$x_i = x_1 + (y_i - y_1)/m$$

$$= 9 + (10 - 9)/1.25$$

$$= 9.8$$

$$m = \frac{9 - 14}{9 - 13} = 1.25$$

So, $I_5 = (\cancel{10}\ 9.8, 10)$

1b/ SP'23

(i) Describe Sutherland-Hodgman Polygon Clipping Algo?

⇒ Steps of Sutherland-Hodgeman Polygon clipping algorithm:

① Polygon can be clipped against each edge of the window once at a time. Window/edge intersections, if any, are easy to find since x or y coordinates are already known.

② Vertices which are kept after clipping against one window edge are saved for clipping against the remaining edges.

③ Note that the number of vertices usually changes and will often increases.

④ We are using the divide and conquer approch.

1b | SP'23

Given,

$W_{xmin} = 1$ $\quad W_{ymin} = 1$

$W_{xmax} = 10$ $\quad W_{ymax} = 10$

and,

$V_{xmin} = 2/4$ $\quad V_{ymin} = 0$

$V_{xmax} = 3/4$ $\quad V_{ymax} = 1/2$

We know that,

$$S_x = \frac{V_{x max} - V_{x min}}{W_{x max} - W_{x min}} = \frac{3/4 - 2/4}{10 - 1} = 1/36$$

$$S_y = \frac{V_{y max} - V_{y min}}{W_{y max} - W_{y min}} = \frac{1/2 - 0}{10 - 1} = 1/18$$

So,

$$N = \begin{bmatrix} 1 & 0 & V_x min \\ 0 & 1 & V_y min \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -W_x min \\ 0 & 1 & -W_y min \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 2/4 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/36 & 0 & 0 \\ 0 & 1/18 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix}$$

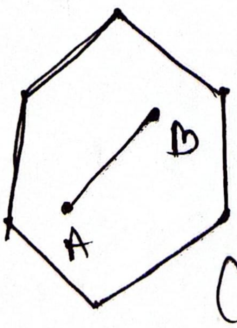
$$= \begin{bmatrix} 0.028 & 0 & 0.47 \\ 0 & 0.056 & -0.055 \\ 0 & 0 & 1 \end{bmatrix}$$

Now, for work station transformation

1ⓐ | SP'22

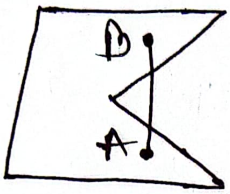
Define Convex and Concave Polygon:

ⓘ Convex: A Polygon is called Convex Polygon if the line Joining any two interior Point of the Polygon lies Completely inside the Polygon.



Convex Polygon

(ii) Concave Polygon: A Polygon is called Concave if the line Joining any two interior Point of the Polygon Passes outside of the Polygon.



Concave Polygon.

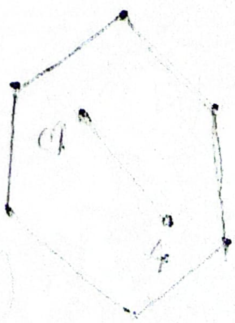
1(a) Aut 22

Q: Viewing Transformation? General transformation matrix of window to ViewPort mapping.

⇒ Viewing tranformation is a system in which, mapping from World Coordinates to Camera Coordinates.

General transformation matrix:

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



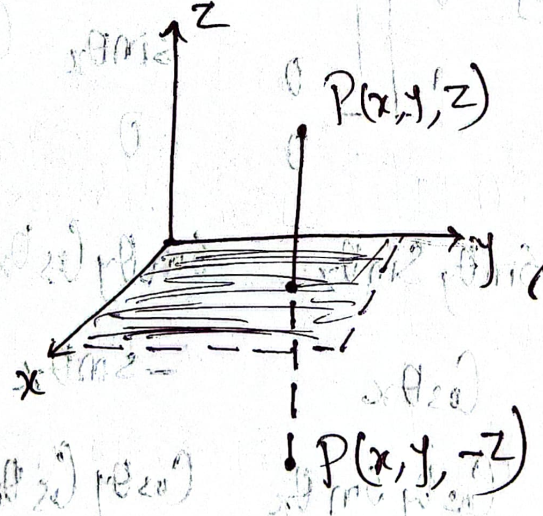
$$T_x = V_{xmin} - S_x \cdot W_{xmin}$$

$$T_y = V_{ymin} - S_y \cdot W_{ymin}$$

Segment - 5

2a | Aut'21

Transformation of mirror reflection with respect to the xy Plane -



The reflection of P(x,y,z) is P'(x,y,-z)

The tranformation Performs this reflection is,

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

2a/Aut22

Tilting: Referred as a rotation about the x-axis followed by a rotation about the y axis.

$$T = R_{\theta_y} \cdot J * R_{\theta_x} \cdot I$$

$$= \begin{bmatrix} \cos\theta_y & \sin\theta_y & 0 \\ 0 & 1 & 0 \\ -\sin\theta_y & \cos\theta_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & \cos\theta_x & -\sin\theta_x & 0 \\ 0 & \sin\theta_x & \cos\theta_x & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos\theta_y & \sin\theta_y \sin\theta_x & \sin\theta_y \cos\theta_x & 0 \\ 0 & \cos\theta_x & -\sin\theta_x & 0 \\ -\sin\theta_y & \cos\theta_y \sin\theta_x & \cos\theta_y \cos\theta_x & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= [x = 30^\circ \text{ and } y = 45^\circ]$$

Given,

Old Coordinates of the object $A = (0,3,3)$, $B = (3,3,6)$

$C = (3,0,1)$, $D = (0,0,0)$

Scaling factor, $S_x = 2$

$S_y = 3$

$S_z = 3$

New Coordinates of $A = (0\times2, 3\times3, 3\times3) = (0,9,9)$

$B = (3\times2, 3\times3, 6\times3) = (6,9,18)$

$C = (3\times2, 0\times3, 1\times3) = (6,0,3)$

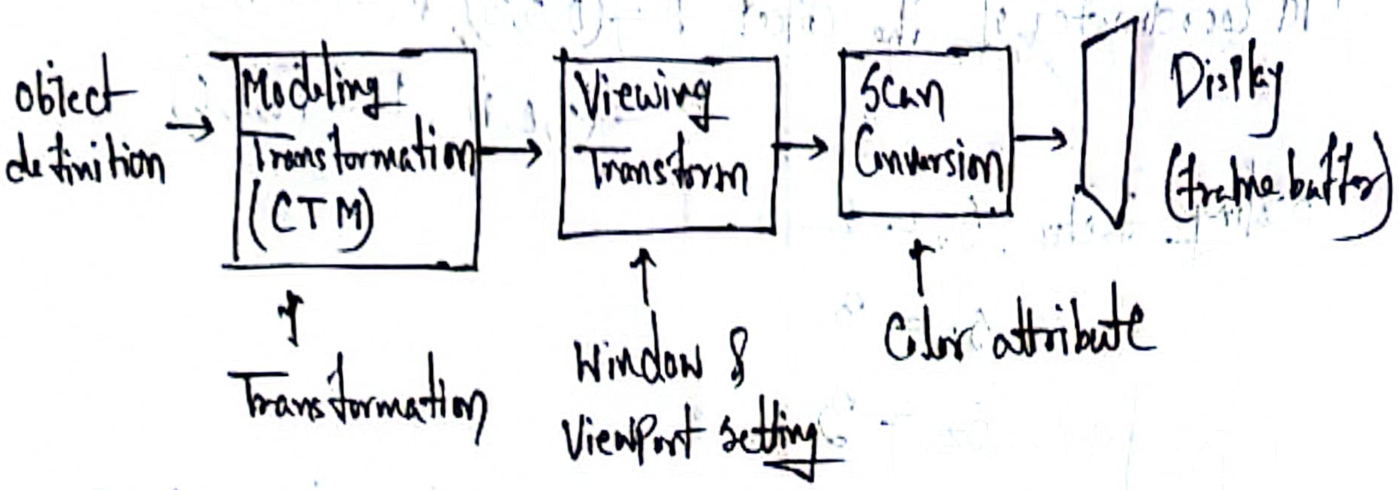
$D = (0\times2, 0\times3, 0\times3) = (0,0,0)$

Scaling বললে (×)
Translation হলে (+) হবে

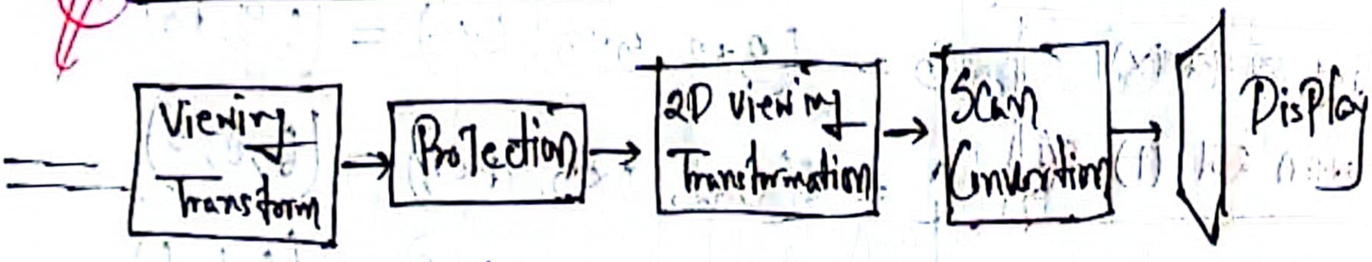
Or, 3D Scaling Matrix ⇒

$$\begin{bmatrix} x_{new} \\ Y_{new} \\ Z_{new} \\ 1 \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} x_{old} \\ Y_{old} \\ Z_{old} \\ 1 \end{bmatrix}$$

2D graphics Pipeline:



3D graphics Pipeline:



2b/Au22

Geometric Transform.	Coordinate Transformation
(i) A changes in the shape or Position of an object	A change in the way that an object Coordinates are represened
(ii) Changes the object itself	(ii) Only Changes the way that the object is represented.
(iii) Rotating 3D model, translation a 2D object, scaling an Image.	(iii) Changing the origin of Co[…] system.
(iv) Application: Computer graphics, robotics, Physics simulation.	(iv) Mathematics, engineering, CG.

2a | SP'23

(a) Cavilier with $\theta = 60°$ $(f = 1)$

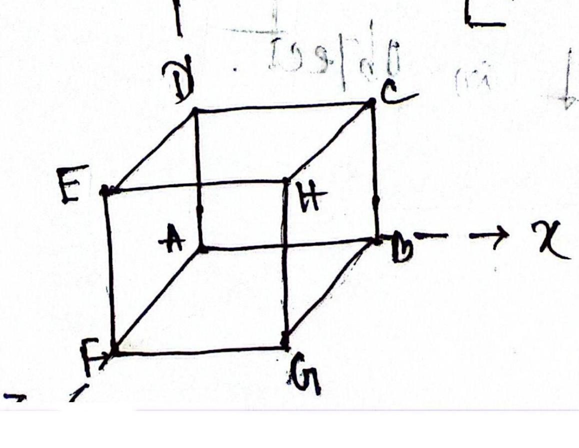
$$\begin{bmatrix} 1 & 0 & f\cos\theta & 0 \\ 0 & 1 & f.\sin\theta & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1/2 & 0 \\ 0 & 1 & \sqrt{3}/2 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = V_1 \; Par_{V_1}$$

(b) Cabinet Projection with $(f = 0.5$ and $\theta = 45°)$

$$\begin{bmatrix} 1 & 0 & f\cos 45 & 0 \\ 0 & 1 & .5\sin 45 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & \sqrt{2}/4 & 0 \\ 0 & 1 & \sqrt{2}/4 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = V_2 \; Par_{V_2}$$

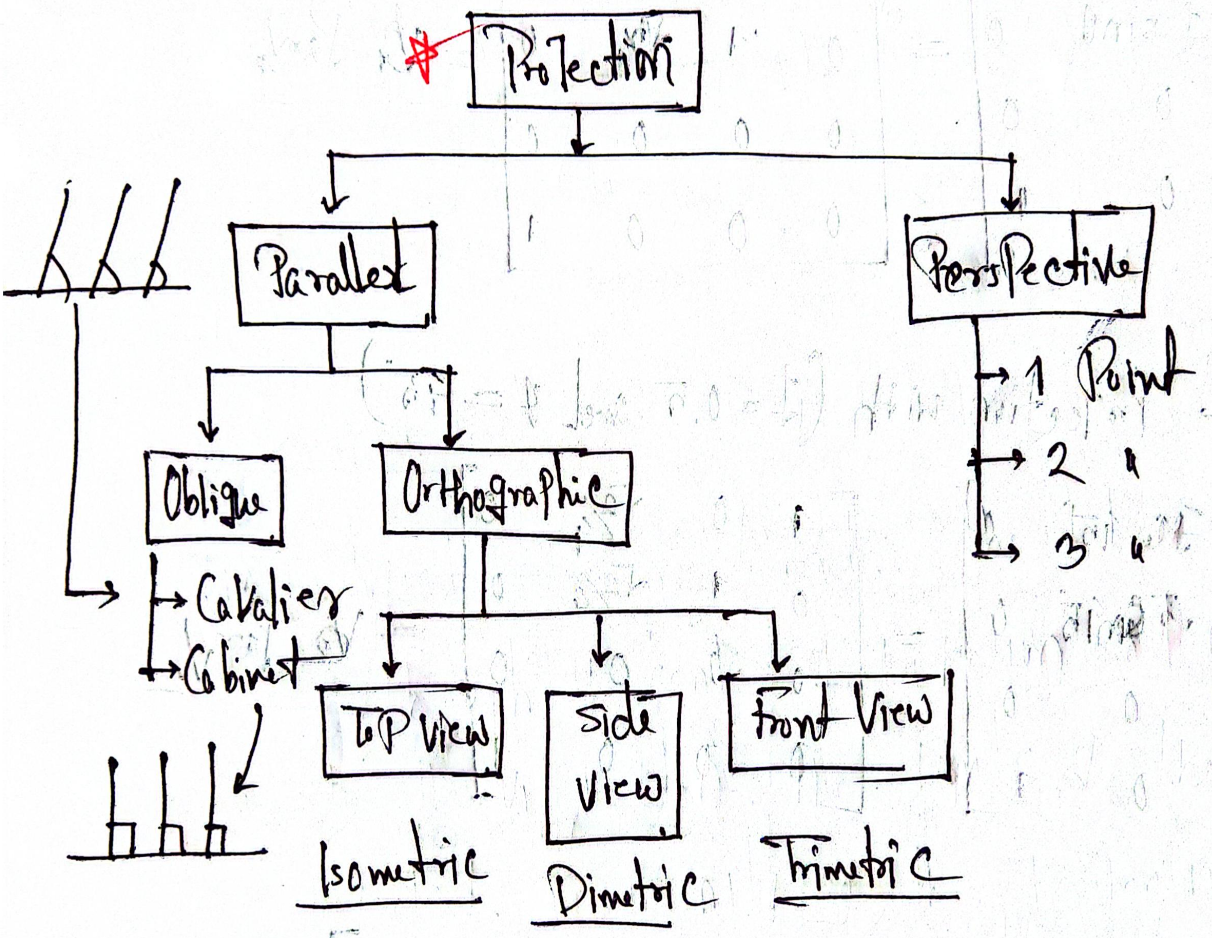
(c)

$$V = (ABCDEFGH) = \begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$



Find the Par $V_1 * V$ and Par $V_2 * V$

Segment - 6



3a|SP'23

Parallel Projection: It's ~~Perse~~ Preserves its scale and shape. This method used by engineers to create working drawing of an object.

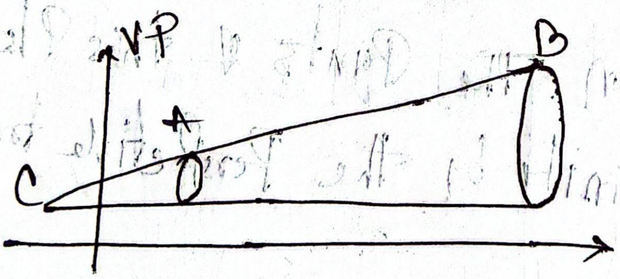
(i) Isometric: The direction of Projection makes equal angles with all of the three Principle axes.

(ii) Dimetric: _ ___ ___ two Principle axes

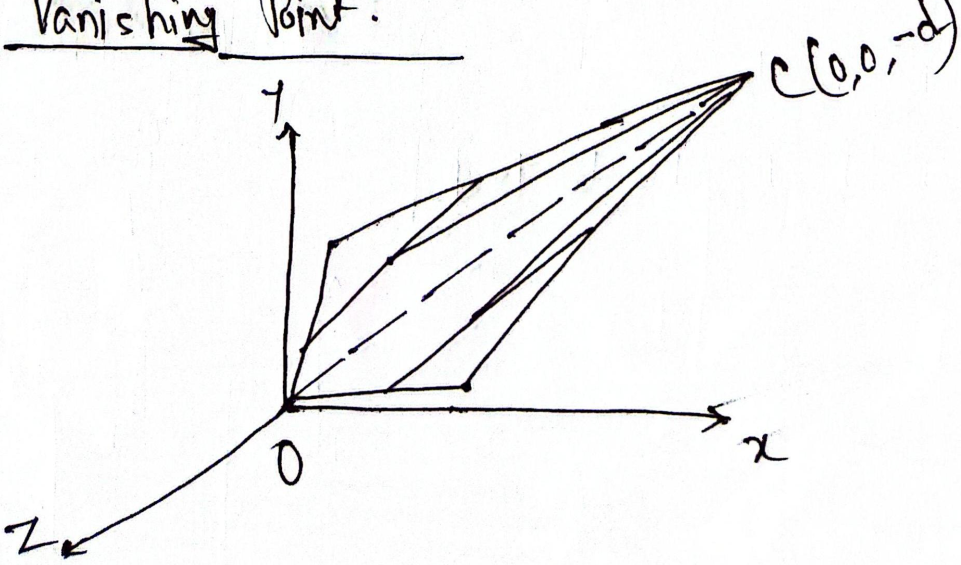
(iii) Trimetric: _ ___ _ unequal angles with all of the three Principle axes.

Anomalies of Perspective Projection:

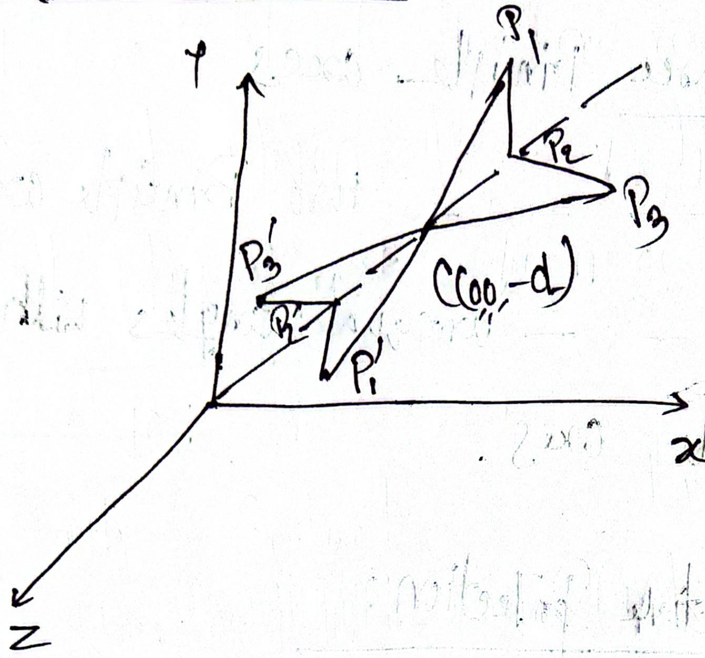
(i) Perspective Forshortening: The farther of an object is from the Center of Projection, the smaller it appers.



(ii) Vanishing Point:



(iii) View Confusion:



(iv) Topological Distortion: Consider the Plane that Passes through the center of Projection and is Parallel to the view Plan. The Points of this Plane are Projected to infinity by the Perspective transformation.

3 (b) [SP'23]

Here, Object matrix $V = (ABCDEFGH)$

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

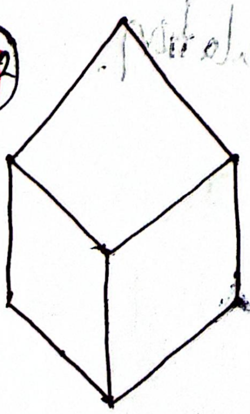
(a) The standard Perspective matrix,

$$Per_K = \begin{bmatrix} d & 0 & 0 & 0 \\ 0 & d & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & d \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 \end{bmatrix}$$

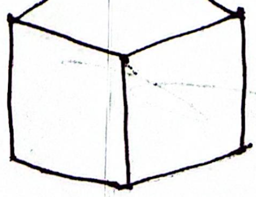
$$Per_K \cdot V = \begin{bmatrix} - & - & - \\ - & - & - \end{bmatrix} * \begin{bmatrix} Per_K \text{---} \end{bmatrix}$$

(b) As it is, find for $d = 10$ - - -.

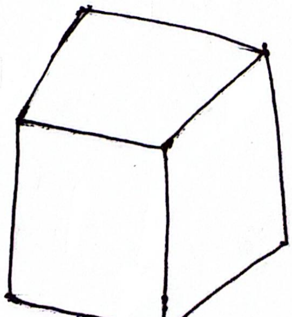
Aut22



Isometric



Dimetric



Trimetric

Segment - 7

SP'23

Wireframe Model: A wireframe model consist of edges, vertices and polygons. Here vertices are connected by edges and polygons are sequences of vertices or edge.

Advantages:

1. Simple to construct
2. Designer need little training.
3. System need less memory.
4. Take less manipulation time.
5. Retreving and editing can be done easily.
6. Consume less time.

DisAdvantages:

1. Image case confusion
2. Not suitable to represent compl solids.
3. Cann't get required informa from this model.
4. Hidden line removal feature not available.
5. Not possible for volume and mass calculation.

SP 23 | Aut 23 | SP 22

* Describe Polygon net model:

(i) Explicit vertex listing

(ii) Polygon listing

(iii) Explicit edge listing

SP'23

Two steps required to determine whether any given Point $P(x_1, y_1, z_1)$ obscures another Point $P_2(x_2\ y_2\ z_2)$:-

(i) Whether the two Points lies on the same Projection line.

(ii) If they do, which Points is in front of the others.

—— o ——

⇒ $P_0(x_0, y_0, z_0)$ and $P_1(x_1, y_1, z_1)$ then

$$\left.\begin{aligned} x &= x_0 + (x_1 - x_0)t \\ y &= y_0 + (y_1 - y_0)t \\ z &= z_0 + (z_1 - z_0)t \end{aligned}\right\} *$$

Aut '21

$$P_3 \begin{array}{c} x_3 \quad y_3 \quad z_3 \\ (2, 4, 6) \end{array}$$

$$P_2 \begin{array}{c} x_2 \quad y_2 \quad z_2 \\ (3, 6, 20) \end{array}$$

$$P_1 \begin{array}{c} x_1 \quad y_1 \quad z_1 \\ (1, 2, 0) \end{array}$$

$$C \begin{array}{c} x_0 \quad y_0 \quad z_0 \\ (0, 0, -10) \end{array}$$

Now,

$$x = x_0 + (x_1 - x_0) * t = 0 + (1-0) * t = t$$

$$y = 0 + (2-0) * t = 2t$$

$$z = -10 + 10t = \cancel{10t} -10 + 10t$$

Testing whether P_2 lies on the line passing through C and P_1,

$$x = t = 3$$

$$y = 2 * 3 = 6$$

$$z = -10 + 10 * 3 = 20$$

Hence, P_2 lies on the passing through C and P_1

Testing for P_3,

$x = t = 2$
$y = 2\times2 = 4$
$z = -10 + 20 = 10$

P_3 not lies on the line

For, $P_1 \Rightarrow x = t = 1$
$y = 2\times1 = 2$
$z = -10 + 10 = 0$

Here, $z_1 < z_2$. So, P_1 is infront of P_2 and P_1 is obscure by P_2 Ans

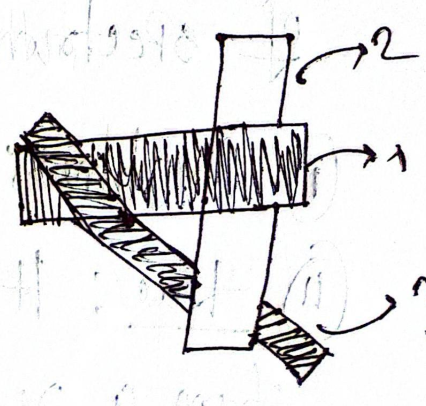
Painters Algorithm:

(i) sorted all the Polygon.

(ii) We started rendering with the farthest Polygon and then we rendered all the Polygons in order.

Depth/Z-buffer Algorithm:

(i) Every time we want to draw Pixel we have to check the depth values.



Segment - 8

Ray Tracing : It is a global illumination model that accounts for the transportation of light energy beyond the direct / local contribution from the light source.

Vector vs Ray :

A vector is defined by its direction and magnitude.

A ray is determined by its direction and starting Point.

sp'23

Light and it's Characteristics :

⇒ Light or visible light, is electromagnetic energy in the 400 to 700nm wavelength range of spectrum.

(i) Brightness

(ii) Hue : It's distinguishes a white light from a red light or a green light.

(iv) Wavelength (v) Frequency (vi) Amplitude ...

(iii) Saturation: It describe the degree of Vividness.

Local illumination and global illumination model:

⇒ A local illumination focuses on the direct impact of the light coming from the source.

⇒ A global model attempts to include such secondary effects as light going through transparent material and light bouncing from one surface to another.

SP'22 $r(t) = 2I + J - 3K$ and $d = I + 2K$

Find Coordinates of the Points on the ray that Corresponds to, $t = 0, 1$ and 3

⇒ We know that, $r(t) = r_0 + td$

Here, $r_0 = 2I + J - 3K$ and $d = I + 2K$

when, $t = 0$: $r(0) = r_0 = 2I + J - 3K \gg (2, 1, -3)$

$t = 1$: $r(1) = r_0 + d = 2I + J - 3K + I + 2K$

$= 3I + J + K \gg (3, 1, -1)$

$r_1 + 3d$

$$t = 3 : \; r(3) = 2I + J - 3K + 3(I + 2K)$$

$$= 5I + J + 3K \gg (5, 1, 3)$$

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