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4th Sem

Group B:-

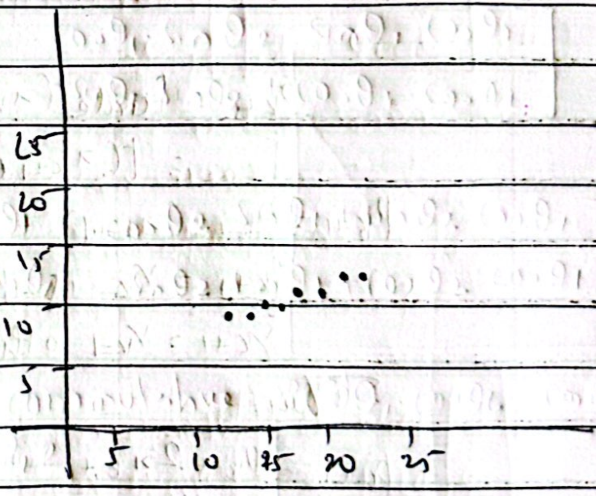
1. Digitilize a line with end points A(11,9) and B(29,17) using Bresenham's line drawing algorithm

Solution $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{29-9}{29-11} =$

$\Delta x = 18$ $\Delta y = 8$ $2\Delta y = 16$ $2\Delta y - 2\Delta x = -20$

$p_0 = 16 - 18$
$= -2$

K	P_k	x_{k+1}	y_{k+1}
1	-2	11	9
2	14	12	9
3	-6	13	10
4	10	14	10
5	-10	15	11
6	6	16	11
7	-14	17	12
8	2	18	12
9	-18	19	13
10	-2	20	13
11	-22	21	14
12	-6	22	14
13	-26	23	15
14	-10	24	15
15	-30	25	16
16	-14	26	16
17	-34	27	17
18	-18	28	17



2) Derive necessary equation for mid point circle algorithm.
Digitize a line with end points A(11,9) and B(29,17)

circle function defined as

$f_{circle}(x,y) = x^2 + y^2 - r^2$

at any point (x,y) satisfies following conditions.

$$f_{circle}(x,y) \begin{cases} <0 & \text{if } f(x,y) \text{ is inside the circle boundary} \\ =0 & \text{if } (x,y) \text{ is on the circle boundary} \\ >0 & \text{if } (x,y) \text{ is outside the circle boundary.} \end{cases}$$

$p_k = f_{circle}(x_{k+1}, y_k - 1/2)$

$= (x_k+1)^2 + (y_k - 1/2)^2 - r^2$

$p_{k+1} = f_{circle}(x_{k+1}+1, y_{k+1} - 1/2)$

$= [(x_{k+1}+1)]^2 + (y_{k+1} - 1/2)^2 - r^2$

$p_{k+1} = p_k + 2(x_k+1) + (y_{k+1}^2 - y_k^2) - (y_{k+1} - y_k) + 1$

$y_{k+1} = y_k$ if $p_k < 0$

$y_{k+1} = y_{k-1}$ otherwise

Thus,

$p_{k+1} = p_k + 2x_{k+1} + 1$ if $p_k < 0$

$p_{k+1} = p_k + 2x_{k+1} + 1 - 2y_{k+1}$ otherwise

Also incremental evaluation of $2x_{k+1}$ and $2y_{k+1}$

$2x_{k+1} = 2x_k + 2$

$2y_{k+1} = 2y_k - 2$ if $p_k > 0$.

At start position $(x_0, y_0) = (0, r)$

$2x_0 = 0$ and $2y_0 = 2r$.

initial decision parameter

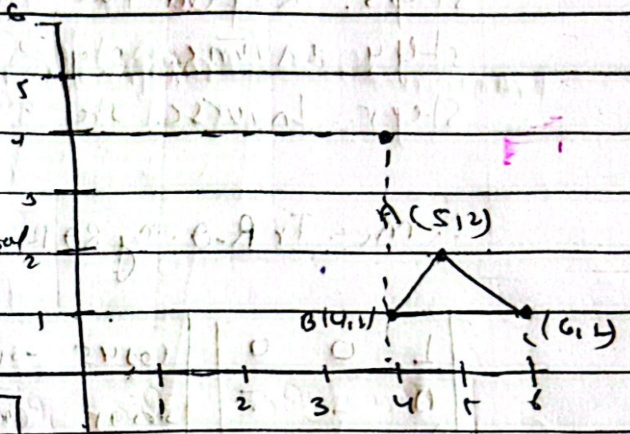
$p_0 = f_{circle}(1, r - 1/2)$

$= 1 + (r - 1/2)^2 - r^2$

$\frac{5}{4} - r$

$$\begin{matrix} -1.0353 & -3.252 & 1 \\ -0.707 & 0.707 & 0 \\ -4 & 1.6567 & 1 \end{matrix}$$

3) A triangle with vertices A(5,2), B(4,1), C(6,1) is required to be rotated in a clockwise direction by 45 degree about any arbitrary point (4,4). Find out the final coordinate position of the triangle after performing the desired transformation.



Solution

Step1:- Translate to origin

Step2:- Rotate about 45°

Step3: Again translate back to original position.

$$T_r T_\theta T_{-r} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ tx & ty & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -tx & -ty & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 4 & 4 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & \sin 45 & 0 \\ -\sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -4 & -4 & 0 \end{bmatrix}$$

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

$$= \begin{bmatrix} 0.7071 & 0.7071 & 1 \\ -0.707 & 0.7071 & 0 \\ 0 & 5.6568 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -4 & -4 & 0 \end{bmatrix} = \begin{bmatrix} -3.2929 & -3.29 & 1 \\ -0.701 & 0.7071 & 0 \\ -4 & 1.6567 & 1 \end{bmatrix}$$

c

4) Reflect a triangle A(1,0), B(3,1), C(1,2) about the line $y = -x+5$

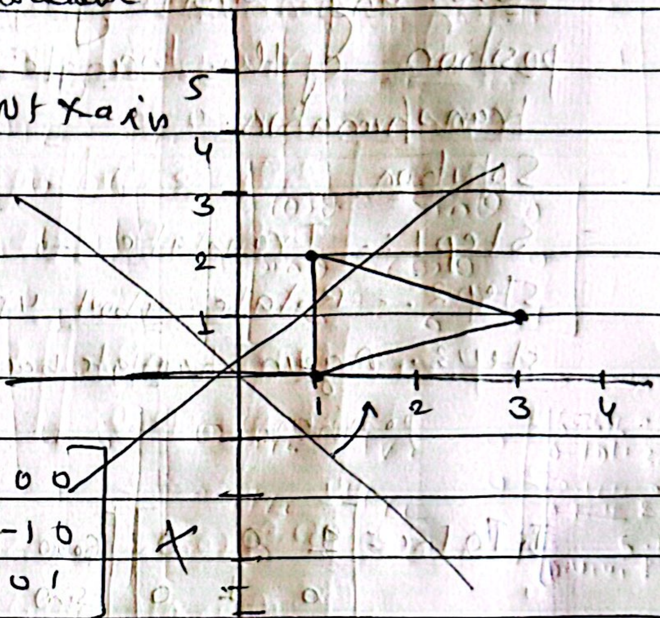
Step1: Translate to origin

Steps:- Rotate the line anti-clockwise direction with

Step3: Reflect the object about x axis

Step4 inverse step 2

Step5: Inverse step 1



$\therefore M_c : T_r R_{-\theta} \cdot M_y R_\theta T_{-r} \cdot P$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times$$

$$\begin{bmatrix} \cos 45 & \sin 45 & 0 \\ -\sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 & 1 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

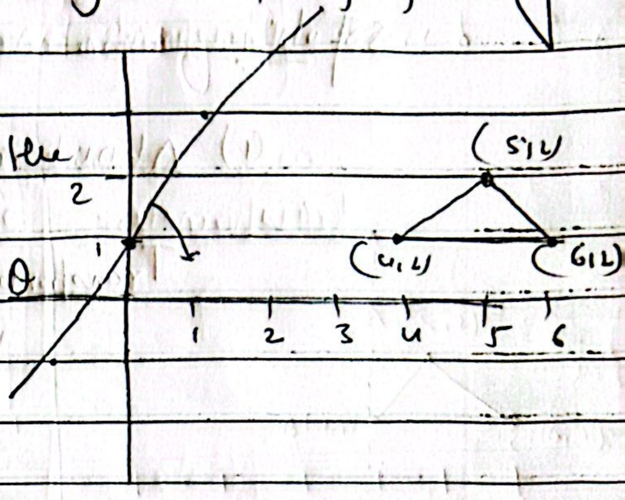
$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 & 1 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$\therefore \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 & 1 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$\therefore \begin{bmatrix} 1.5 & 4.5 & 1.5 \\ 11.5 & 13 & 8.5 \\ 1 & 1 & 1 \end{bmatrix}$$

5. A triangle with vertices A(5,2), B(4,1) C(6,1) is required to be reflected about an arbitrary line y = 2x+1. Find out the final coordinates position of the triangle after performing the desired transformation.

Solution



1) Step 1:- Translate the point (0,C) to the origin.
2) Rotate the line clockwise with θ
3) Reflect the object about x-axis
4) Inverse of step 2
5) Inverse of step 1.

$\therefore M_L = T_r \cdot R_\theta \cdot M_x \cdot R_{-\theta} \cdot T_{-r} \cdot P$

$y = 2x+1$

$m = 2$ $c = 1$

$\tan\theta = \frac{2}{1} = \frac{P}{b} =$

$H = \sqrt{P^2+b^2} = \sqrt{2^2+1} = \sqrt{5}$

$\sin\theta = P/H = 2/\sqrt{5}$, $\cos\theta = B/H = 1/\sqrt{5}$

now

$$= \begin{bmatrix}1&0&0\\0&1&1\\0&0&1\end{bmatrix}\begin{bmatrix}\cos\theta&-\sin\theta&0\\\sin\theta&\cos\theta&0\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&-1&0\\0&0&1\end{bmatrix}\begin{bmatrix}\cos\theta&\sin\theta&0\\-\sin\theta&\cos\theta&0\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&1&-1\\0&0&1\end{bmatrix}\begin{bmatrix}5&4&6\\2&1&1\\1&1&1\end{bmatrix}$$

$$= \begin{bmatrix}1&0&0\\0&1&1\\0&0&1\end{bmatrix}\begin{bmatrix}1/\sqrt{5}&-2/\sqrt{5}&0\\2/\sqrt{5}&1/\sqrt{5}&0\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&-1&0\\0&0&1\end{bmatrix}\begin{bmatrix}1/\sqrt{5}&2/\sqrt{5}&0\\-2/\sqrt{5}&1/\sqrt{5}&0\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&1&-1\\0&0&1\end{bmatrix}\begin{bmatrix}5&4&1\\2&1&1\\1&1&1\end{bmatrix}$$

$$= \begin{bmatrix}1&0&0\\0&1&1\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&-1&0\\0&0&1\end{bmatrix}\begin{bmatrix}1&0&0\\0&1&-1\\0&0&1\end{bmatrix}\begin{bmatrix}5&4&6\\2&1&1\\1&1&1\end{bmatrix} = \begin{bmatrix}5&4&6\\0&1&1\\1&1&1\end{bmatrix}$$

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6) A triangle with vertices A(5,2), B(4,1), C(6,1) is required to be rotated by 45 degree in counter clockwise direction about
(i) origin (ii) line $y=5$.

Solution

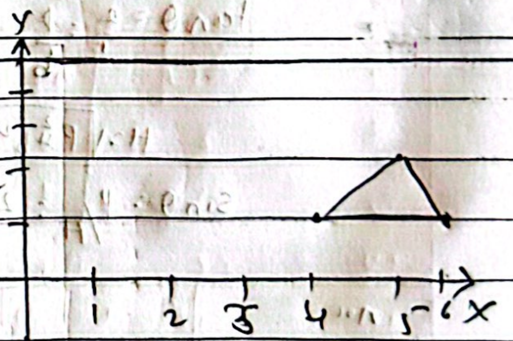
(i) About origin

Transformation matrix: $\begin{bmatrix} 5 & 4 & 6 \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$= \begin{bmatrix} 5 & 4 & 6 \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 6.3 \\ 2.1 \\ 0.\ldots \end{bmatrix}$

(ii) About line $y=5$.

1) Translate the points so that line $y=5$ become x-axis
2) Rotate the point by 45° in counter
3) Translate back to origin position



$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix}$

$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0.7071 & -1.414 \\ 0.7071 & 0.7071 \\ 0 & 0 \end{bmatrix}$

now,

$P' = P \cdot T_{rm} = \begin{bmatrix} 5 & 4 & 6 \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0.7071 & -1.414 & 0 \\ 0.7071 & 0.7071 & 0 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow \begin{bmatrix} 6.7071 \\ 4.5457 \\ 1 \end{bmatrix}$

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8) Rotate triangle A(0,0), B(1,1), C(5,2) about origin and about point (-1,-1) by 45 degree in counter clockwise direction

(i) about origin

Transformation matrix:-

$$\begin{bmatrix} 0 & 1 & 5 \\ 0 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0.7071 & 0.7071 \\ 0.7071 & -0.7071 \\ 1.4142 & 0 \end{bmatrix}$$

Transformation:

$$\begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 1 \\ 5 & 2 & 1 \end{bmatrix} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 1 \\ 0 & \sqrt{2} & 1 \\ \frac{3\sqrt{2}}{2} & \frac{7\sqrt{2}}{2} & 1 \end{bmatrix}$$

About point (-1,-1)

1) Translate about the origin
2) Rotate about 45°
3) Translate to original position

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

$$= \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{\sqrt{2}}{2} & -\sqrt{2}/2 & 0 \\ \sqrt{2}/2 & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0.7071 & -0.7071 & 0 \\ 0.7071 & 0.7071 & -0 \\ 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 1 \\ 5 & 2 & 1 \end{bmatrix} \begin{bmatrix} 0.7071 & -0.7071 & 0.999 \\ 0.7071 & 0.7071 & -0.414 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 1.4142 & 0 & 1.585 \\ 4.9497 & -2.121 & 5.1 \end{bmatrix}$$

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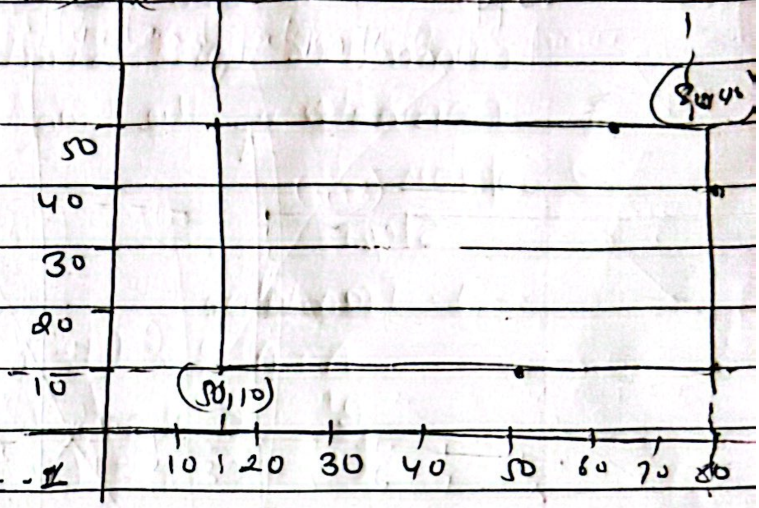
(11) Use cohen sutherland algorithm to clip two lines (60,50) and (100,10) against window (50,10), (80,40)



solution finding region code.

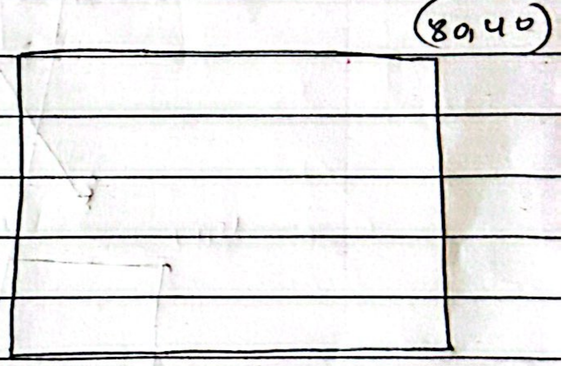
$p_1 = 1000$

$p_2 = 0010$

AND 0000 partially visible

Now

$$slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10-50}{100-60} = \frac{-40}{40} = -1$$



Now

$i_1 (x, y_{max}) = (x, 40)$

$$x = \frac{1}{m}(y_{max} - y_1) + x_1$$

$$= \frac{1}{-1}(40 - 50) + 60$$

$$= \frac{-10}{-1} + 60 = 70$$

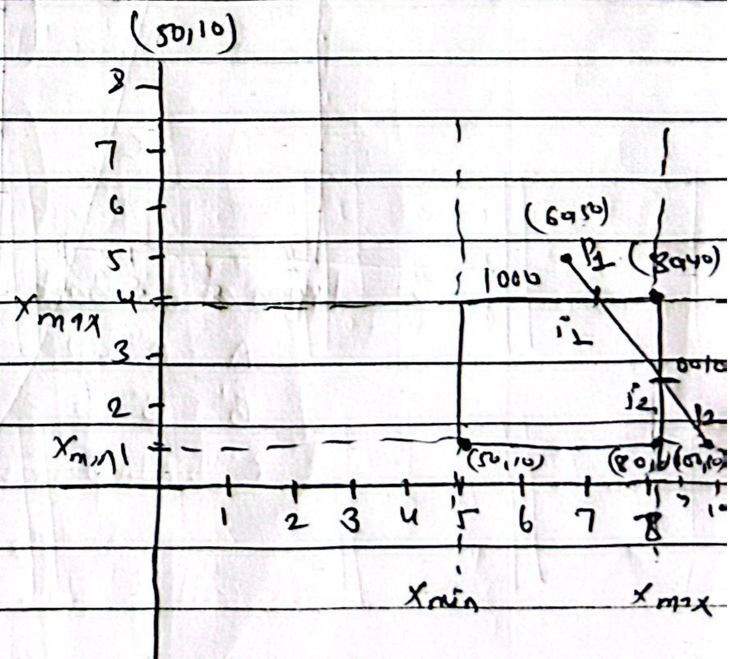
$i_2 (x_{min}, y) = (80, ?)$

$$y = m(x_{min} - x_1) + y_1$$

$$= -1(80 - 60) + 50$$

$$= -20 + 50$$

$$= 30$$



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13) prove two successive rotation are transformation commute

We have,

$$R = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

Also,

$$R_1R_2 = \begin{bmatrix} \cos\theta_1 & \sin\theta_1 \\ -\sin\theta_1 & \cos\theta_1 \end{bmatrix} \begin{bmatrix} \cos\theta_2 & \sin\theta_2 \\ -\sin\theta_2 & \cos\theta_2 \end{bmatrix}$$ and

$$R_2R_1 = \begin{bmatrix} \cos\theta_2 & \sin\theta_2 \\ -\sin\theta_2 & \cos\theta_2 \end{bmatrix} \begin{bmatrix} \cos\theta_1 & \sin\theta_1 \\ -\sin\theta_1 & \cos\theta_1 \end{bmatrix}$$

$$\therefore R_1R_2 \begin{bmatrix} \cos\theta_1 \cdot \cos\theta_2 - \sin\theta_1 \sin\theta_2 & \cos\theta_1 \cdot \sin\theta_2 - \sin\theta_1 \cdot \cos\theta_1 \\ -\sin\theta_1 \cdot \cos\theta_2 - \cos\theta_1 \cdot \sin\theta_2 & -\sin\theta_1 \cdot \sin\theta_2 + \cos\theta_1 \cdot \cos\theta_2 \end{bmatrix}$$

$$R_2R_1 \begin{bmatrix} \cos\theta_2 \cdot \cos\theta_1 - \sin\theta_2 \sin\theta_1 & \cos\theta_2 \cdot \sin\theta_1 + \sin\theta_2 \cos\theta_1 \\ -\sin\theta_2 \cdot \cos\theta_1 - \cos\theta_2 \sin\theta_1 & -\sin\theta_2 \cdot \sin\theta_1 + \cos\theta_2 \cos\theta_1 \end{bmatrix}$$

Since multiplication is commutative $\cos\theta_1 \cdot \cos\theta_2 = \cos\theta_2 \cdot \cos\theta_1$

Therefore $R_1R_2 = R_2R_1$

14) Triangle with vertices A(1,1), B(7,1), C(4,3) is required to be rotated about any arbitrary fixed point (4,2) counter clock wise direction by 90 degree. What will be the final coordinates of the triangle?

→ Solution

Steps:-

1. Translation

$$A' = A - P = (1-4, 1-2) = (-3, -1)$$

$$B' = B - P = (7-4, 1-2) = (3, -1)$$

$$C' = C - P = (4-4, 3-2) = (0, 1)$$

2. Rotation

The 90-degree counter clock wise direction matrix

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

Then $$A'' = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} -3 \\ -1 \end{pmatrix} = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$$

$$B'' = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 3 \\ -1 \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$$

$$C'' = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} -1 \\ 0 \end{pmatrix}$$

3. Translation Back.

$$A''' = A'' + P = (1+4, -3+2) = (5, -1)$$

$$B''' = B'' + P = (1+4, 3+2) = (5, 5)$$

$$C''' = C'' + P = (-1+4, 0+2) = (3, 2)$$ ✓

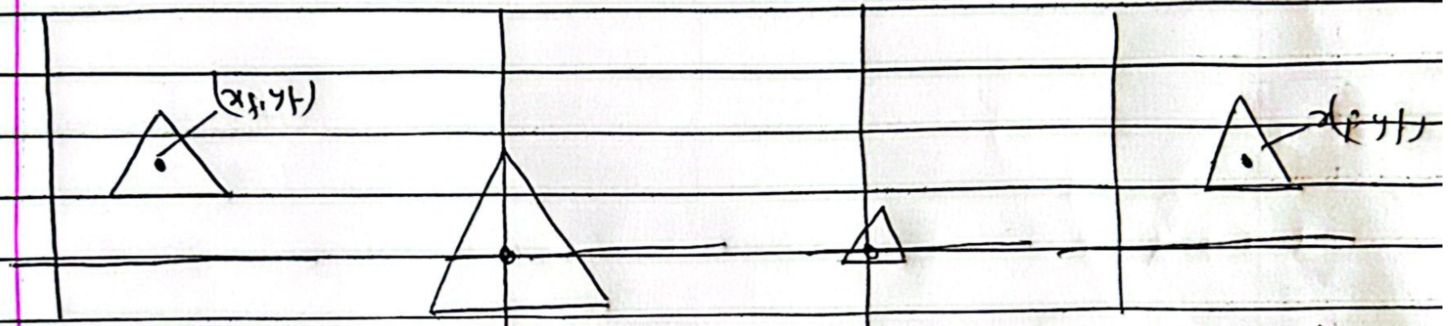
Q. Find Scaling transformation matrix to scale S_x, S_y, S_z units with respect to a fixed point $p(x, y, z)$.

→ Translate object so that the fixed point coincides with the coordinate origin.

→ Scale the object with respect to the coordinate origin.

→ use the inverse translation of step1 to return the object to its original position

$$p' = [T(x_f, y_f) \cdot S(s_x, s_y) \cdot T(-x_f, -y_f)] p$$



original position of object and pivot point

Translate object so that fixed point (x_f, y_f) is at

c) scale object with respect to origin

Translate object back so its fixed point return to position (x_f, y_f)

The homogeneous matrix equation is

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & x_f \\ 0 & 1 & y_f \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -x_f \\ 0 & 0 & -y_f \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

2

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Assignment

[Group A]

1. Raster Refresh system

characteristic

1) Resolution:

determined by the number of pixels in a grid. common resolutions include 1920 x 1080 (Full HD), 3840 x 2160 (4K) etc

2) Refresh Rate:

Refresh Rate typically ranges from 60 Hz to 240 Hz.

3) Image Rendering:

The entire screen is refreshed multiple time per second

2) Vector Refresh Systems

Characteristic:

1) Resolution

The resolution depends on the precision of the deflection system and the analog nature of the display.

2) Refresh Rate:

variable, typically slower than raster systems. Depends on the complexity of the image

3) Image Rendering:-

Draws images by moving the electron beam directly to trace out shapes rather than scanning a grid.

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3) plasma panels :-
characteristic :

1. Resolution:
High resolution available, commonly used in large displays (eg, 1080p, 4K).

2) Refresh Rate
Typically 60Hz to 120Hz

3) Image Rendering :-
Uses small cells containing electrically charged ionized gases to produce image.

4) LCDs
Characteristics :-

1. Resolution :-
very high resolutions available, common resolution includes 1920X1080/ 2560X 1440 etc.

2) Refresh Rate :-
Typically 60Hz to 144Hz.

3) Image Rendering :-
Uses liquid crystals that align to modulate light from a backlight, creating images.

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2)

Raster Scan System	Random Scan system
1. They are composed of pixels	1. They are composed of paths
2) It is less expensive	2) It is more expensive
3) modification is difficult	3) modification is easy
4) Resolution is low	4) Resolution is high
5) It uses interlacing	5) It doesnot uses interlacing
6) solid pattern is easy to fill	6) solid pattern is difficult to fill
7) occupy ~~more~~ more space	7) Occupy less space

3) Solution

for the system with resolution 640 by 400

Resolution (No of pixels) = 640 x 400 = 256000

Storage = 12 bits per pixel

Size of frame buffer = 640 x 400 x 12

= 3072000 bytes ⇒ 384 mbytes

for the system with resolution 1280 by 1024.

Resolution (No of pixels) = 1280 x 1024 = 1310720 pixels

Storage = 12 bits per pixel

Size of frame buffer = 1280 * 1024 * 12 = 15728640 bits

= 1966080 bytes

for the system with resolution 2560 by 2048.

Resolution (No of pixels) = $\cancel{1280}_{2560} * \cancel{1024}^{2048}$ = 1310 720 pixels.

Storage = 12 bits per pixels.

Size of frame Buffer = Resolution * bits per Pixel

= ~~1280 * 1024~~

= 2560 * 2048 * 12 / 8 bytes.

= 1966 080 bytes

24 bits

for 640 by 400.

Resolution = 640 * 400 = 256000

Storage = 24 bits per pixel

size of frame Buffer = 640 * 400 * 24 bits

= 6144000 bits

= 768000 bytes

for 1280 by 1024

Resolution = 1280 * 1024 = 1310 720

Storage = 24 bits per pixel

Size of frame Buffer = 1280 * 1024 * 24

= 31457 280 bits

= 3932160 bytes.

for 2560 by 2048

Resolution = 2560 * 2048 = 5242 880

Storage = 24 bits per pixel

Size of frame Buffer = 2560 * 2048 * 24

= 125829120 bits

= 15728640 bytes.

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4) Solution

Given,

Screen size = 8-inch by 10-inch

Resolution = 10 * 100 * 8 * 100

= 1000 * 800 => 800,000 pixels

Storage = 9 bits per pixels

Size of frame buffer = Resolution * bits per pixels

= 800,000 * 9

= 7,200,000 bits

= 9,00,000 bytes

5) Solution

The system of 640 by 480 frame buffer with 12 bit per pixel

Resolution = 640 * 480 = 307200 pixels

Storage = 12 bits per pixel

Size of frame buffer = 640 * 480 * 12

= 3686400 bits

Transfer Rate (1 sec) = 10^5 bits per sec

10^5 bits = 1 second

3686400 bits $= \frac{1}{10^5} \times 3686400$

= 36.864 sec

The system of 1280 by 1024 frame buffer with 24 bits per pixel.

Resolution = 1280 * 1024 = 1310720 pixels

Storage = 24 bits per pixel

Size of frame Buffer = 1280 * 1024 * 24

= 31457280 bits

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Transfer Rate (per sec) = 10^5 bits per sec

10^5 bits = 1 sec

31457280 bits = $\frac{1}{10^5} \times 31457280$

= 314.57280 sec

6) Solution

Given,

for the system, 640*480

Resolution = 640*480 => 307200 pixels.

No of pixels, in 60 frames = 640*480*60 (Resolution*n

= 18432000 pixels.

Refresh rate = 60 frames per sec

1sec = ~~frame~~ 60 frames per sec

60 frames = 1 sec

~~18432000 frames~~ = $\frac{1}{60}$ x

1 frame = $\frac{1}{60 \text{ frame per sec}}$ sec

= $\frac{1}{18432000}$ sec => 5.4×10^{-8} sec

The system with resolution of 1280 * 1024

Resolution (1 frame) = 1280 * 1024 pixels = 1310720 pix

No of pixels in 60 frames = 1310720 * 60

= 78643200 pixels

Refresh Rate = 60 frame per sec.

1 sec = 78643200 pixel

1 pixel = $\frac{1}{78643200}$ sec

= 1.2×10^{-8} sec

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8)

	Sonic Touch Panel	Sonic tablet.
	1. Touch-sensitive interface for direct interaction with a display	1. Graphical input device for drawing or writing.
Clarity	2) Offers high optical quality	2) Not applicable.
Response time	3) Fast Response time	3) comparatively low response time
cost	4) More expensive	4) more affordable
	5) Integrated with the display screen	5) Separate from the display
Applicat-	6) ATMs, industrial control etc	6) Graphic design, CAD, digital Arts.

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(8) Bresenham's Line Drawing Algorithm

start from left end point (x_0, y_0) steps to each successive column (x sample) and plot the pixels whose scan line (y value) is closest to the line

After (x_k, y_k), the choice could be (x_{k+1}, y_k)

(x_{k+1}, y_{k+1})

$y = m(x_k+1) + b$

Then,

$d_1 = y - y_k$

$= m(x_k+1) + b - k$

and

$d_2 = (y_k+1) - y$

$= y_k+1 - m(x_k+1) - b$

Difference between separations

$d_1 - d_2 = 2m(x_k+1) - 2y_k + 2b - 1$

Defining decision parameter

$p_k = \Delta x (d_1 - d_2)$

$= 2\Delta y\, x_k - 2\Delta x \cdot y_k + c$

Sign of p_k is same as that of $d_1 - d_2$ for $x > 0$

$p_{k+1} = 2\Delta x\, y_{k+1} - 2\Delta x\, y_{k+1} + c$

$p_{k+1} - p_k = 2\Delta y(x_{k+1} - x_k) - 2\Delta x(y_{k+1}$

$p_{k+1} = p_k + 2\Delta y - 2\Delta x(y_{k+1} - y_k)$

for recursive calculation, initially

$p_0 = 2\Delta y - \Delta x$

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10. a) Refresh Rate:-

The refresh rate is the number of times per second that a display hardware update its buffer. It is measured in Hertz(Hz).

Importance:-

- A higher refresh rate results in smoother motion and reduces the flicker that can cause eye strain.
- Common refresh rate for monitors and TVs include 60Hz, 120Hz and 240Hz

Application

- Essential in gaming monitors, VR headsets and high-end video displays to ensure a smooth visual output.

b) Aspect-Ratio

The aspect ratio is the proportional relationship between the width and height of a display screen or image. It is expressed as two numbers separated by a colon (eg 16:9, 4:3)

Importance

- Determines the shape of the display and how content fits on the display.
- Different aspect ratio are suited to different types of content and applications.

For example, 16:9 is common for HDTVs and computer monitor while 4:3 was common for older TVs monitor.

Applications

- Used in video production, screen design and digital photography.

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c) **Resolution:**

Resolution refers to the number of distinct Pixels that can be displayed on a screen, typically expressed as width x hight (eg 1920 x 1080)

-Importance

- Higher resolution means more pixels and sharper and Clearer images. It is a critical factor in image quality.
- Important in various fields including digital display, Printing and imaging

Applications

- In monitors, TVs and mobile device to determine the clarity and details of the displayed image

d) **Persistence**

Persistence refers to the duration of a pixel on a display remains lit after being activated, often measured in miliseconds(ms)

-Importance

- High persistence can lead to motion blur and ghosting effects in fast-moving images. Low persistence is Preferable for Clearer, sharper image during motion.
- Critical for gaming and video Application where fast movements are common.

Applications:

- Important in CRT displays, where it was a major factor in image quality. In modern devices, lower persistence rates improve the visual experience for dynamic content.

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