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Section 14

CSE423

Assignment 02

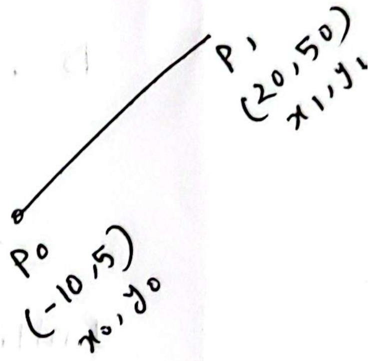
Ans no 1

a) $P(t) = P_0 + t(P_1 - P_0)$

$= (x_0, y_0) + t(x_1 - x_0, y_1 - y_0)$

$= x_0 + t(x_1 - x_0), y_0 + t(y_1 - y_0)$

when $t = 3/4$,



$P(3/4) = -10 + \frac{3}{4}(20+10),$

$5 + \frac{3}{4}(50-5)$

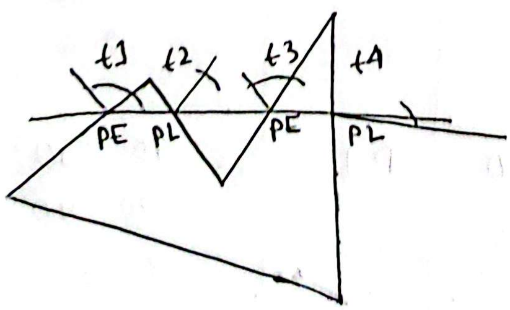
$= 12.5, 38.75$

$P(7) = -10 + 7(20+10), 5 + 7(50-5)$

$= 200, 320$

The point doesn't lie inside the segment.

b) Cyrus Beck Algorithm doesnot work with concave polygon clip region.



$t_E = t_3$

$t_L = t_2$

$t_E > t_L$

So the whole line is discarded though some segments should be displayed.

(c)

$x_{min} = -10, \quad y_{min} = 10$

$x_{max} = 50, \quad y_{max} = 150$

$x_0 = 30, \quad y_0 = 40$

$x_1 = 100, \quad y_1 = 90$

$$D = (x_1 - x_0,\ y_1 - y_0)$$
$$= (100-30,\ 90-40)$$
$$= (70, 50)$$

Initially, $t_E = 0$, $t_L = 1$

Boundary	N_i	$N_i \cdot D$	PE/PL	t	t_E	t_L
Left	(-1,0)	-70	PE	$\frac{-(30+10)}{100-30} = -0.57$	0	1
Right	(1,0)	70	PL	$\frac{-(30-50)}{100-30} = 0.286$	0	0.286
Bottom	(0,-1)	-50	PE	$\frac{-(40-10)}{90-40} = -0.6$	0	0.286
Top	(0,1)	50	PL	$\frac{-(40-150)}{90-40} = 2.2$	0	0.286

$t_L > t_E$

$P(0)$ and $P(0.286)$ are the true clip intersection

$P(0) = (x_0, y_0) + 0 \times D$

$= (30, 40)$

$P(0.286) = (x_0, y_0) + 0.286 \times D$

$= (30, 40) + 0.286 \times (70, 50)$

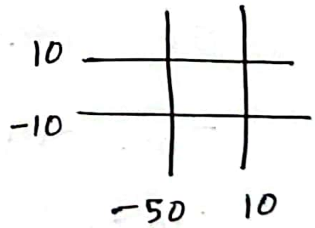
$= (30 + 20.02, 40 + 14.3)$

$= (50.02, 54.3)$

$(30, 40)$ and $(50.02, 54.3)$ are the endpoints of the clipped line.

<u>Ans no 2</u> (a)

$x_{min} = -50$, $y_{min} = -10$



$x_{max} = 10$, $y_{max} = 10$

$x_1 = -20$, $y_1 = -30$

$x_2 = 5$, $y_2 = 20$

Outcode 1 = 0100

Outcode 2 = 1000

Outcode 1 AND Outcode 2 = 0000

so partially inside.

Outcode 1 has bottom bit.

Applying bottom intersection:

$y = y_{min} = -10$

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

$= -20 + \frac{5+20}{20+30}(-10+30)$

$= -10$

Outcode 1 = 0000 (recalculated)

Outcode 1 AND outcode 2 = 0000

Outcode 2 has Top bit.

$x_1 = -10, \; y_1 = -10, \; x_2 = 5, \; y_2 = 20$

Applying top boundary intersection:

$y = y_{max} = 10$

$x = x_2 + \frac{1}{m}(y_{max} - y_2)$

$= 5 + \frac{5+10}{20+10}(10-20)$

$= 0$

Outcode 2 = 0000 (recalculated)

so completely inside.

The clipped segment is between (0,0) to (0,0)

which is just a single point.

b) The Cohen-Sutherland Line Clipping Algorithm works best in the following scenarios:

i) Fast rejection / acceptance when most lines are fully inside or outside the rectangular clipping window.

ii) Optimized for axis-aligned rectangular clipping regions.

iii) Efficient for sparse, well-distributed lines, reducing unnecessary intersection calculation

Ans no 3

[Shear] [trans] [Scaling] [rotate]

$$\begin{bmatrix} 1 & 0 & 20 \\ 0 & 1 & 10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 6 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 5 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos(-30) & -\sin(-30) & 0 \\ \sin(-30) & \cos(-30) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -5 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 8 & 0 \\ 7 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -2 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}$$

To find initial 3 vertices, we need to do inverse.

[rotate] [scaling] [trans] [shear]

$$\begin{bmatrix} 1/6 & 0 & 0 \\ 0 & 1/6 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -20 \\ 0 & 1 & -10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -8 & 0 \\ -7 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -2 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 5 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -5 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0.7272 & -1.236 & 2.259 \\ -0.926 & -0.521 & -1.586 \\ 0 & 0 & 1 \end{bmatrix}$$

$$M \cdot P' = \begin{bmatrix} 0.7272 & -1.236 & 2.259 \\ -0.926 & -0.521 & -1.586 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -7.554 & -4.283 & -10.75 \\ -20.51 & -14.2 & -20.62 \\ 1 & 1 & 1 \end{bmatrix}$$

Initial 3 vertices: $(-7.554, -20.51)$, $(-4.283, -14.2)$, $(-10.75, -20.62)$

In the given scenario, we have rotation, scaling, translation and shearing. Rotation is represented by a matrix involving sine and cosine. Scaling modifies the diagonal elements of the transformation matrix. Translation adds a constant vector (last column in homogenous coordinates). Shearing modifies the off-diagonal elements of the transformation matrix. Since affine transformations are a combination of these linear transformation and translation, we can say, all of the given transformation indicates affine transformation. Affine transformation preserves parallel lines. So, parallel lines were preserved at the end after buts nose transformations.