CSE423: Computer Graphic

Assignment 02

Submitted by.

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Ans to the Ques. No. 01

(a)

Start, $P_0 = (-10, 5) = (x_0, y_0)$

End, $P_1 = (20, 50) = (x_1, y_1)$

$\therefore P(t) = P_0 + t(P_1 - P_0)$

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

$= (-10, 5) + t(20 - (-10), 50 - 5)$

$\therefore P(t) = (-10, 5) + t(30, 45)$

When, $t = 3/4$,

$P(3/4) = (-10, 5) + 3/4\,(30, 45)$

$= (-10, 5) + (22.5, 33.75)$

$\therefore P(3/4) = (12.5, 38.75)$

When $t = 7$,

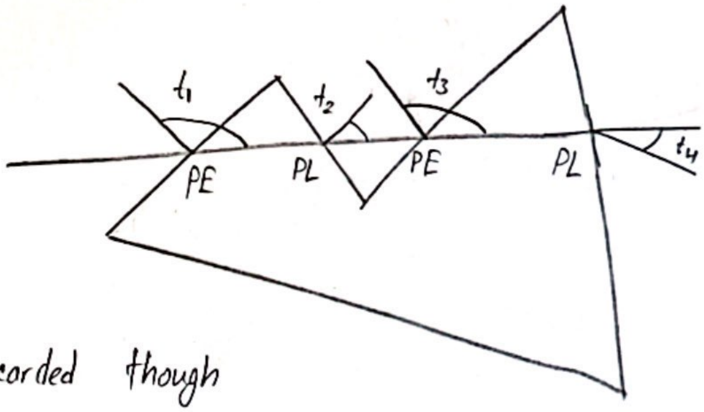
$P(7) = (-10, 5) + 7(30, 45)$

$= (-10, 5) + (210, 315)$

$\therefore P(7) = (200, 320)$ which is outside line segment as $t > 1$.
and $200 > x_1$ and $320 > y_1$.

(b)

Cyrus-Beck algorithm will not work with concave polygon clip region.



$t_E = t_3$

$t_L = t_2$

$t_E > t_L$

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

(c)

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

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

Points:

$x_0 = 30$ $\quad y_0 = 40$

$x_1 = 100$ $\quad y_1 = 90$

$D = (x_1 - x_0, \; y_1 - y_0)$

$= (100-30, \; 90-40)$

$= (70, \; 50)$

$t_E = 0, \quad t_L = 1$

Boundary	N_i	$N_i \cdot D$	t	PE/PL	t_E (max)	t_L (min)
Left	$(-1,0)$	-70	$\frac{-(30-(-10))}{100-30} = -0.57$	PE	0	1
Right	$(1,0)$	70	$\frac{-(30-50)}{100-30} = 0.29$	PL	0	0.29
Bottom	$(0,-1)$	-50	$\frac{-(40-10)}{90-40} = -0.6$	PE	0	0.29
Top	$(0,1)$	50	$\frac{-(40-150)}{90-40} = 2.2$	PL	0	0.29

$0 \le t_E \le t_L \le 1$. $\therefore$ The line segment needs to be clipped.

$\therefore P(0) = (x_0, y_0) = (30, 40)$

$\therefore P(0.29) = (x_0, y_0) + 0.29 \times D$

$= (30, 40) + 0.29\,(70, 50)$

$= (30, 40) + (20.3, 14.5)$

$= (50.3, 54.5) \approx (50, 55)$

$P(0)$ and $P(0.29)$ are the true clip intersection.

$(30, 40)$ and $(50\cancel{.3}, \overset{55}{\cancel{54.5}})$ are the endpoints of the clipped line.

Ans. to the Ques. No. 02

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

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

Points:

$x_1 = -20$ $x_{min} \le x_1 \le x_{max}$ $\therefore$ bit 0 = 0 bit 1 = 0

$y_1 = -30$ $y_1 < y_{min}$ $\therefore$ bit 2 = 1 bit 3 = 0

$\therefore$ outcode 1 = 0100

$x_2 = 5$ $x_{min} \le x_2 \le x_{max}$ $\therefore$ bit 0 = 0 bit 1 = 0

$y_2 = 20$ $y_2 > y_{max}$ $\therefore$ bit 2 = 0 bit 3 = 1

$\therefore$ outcode 2 = 1000

Now, outcode 1 AND outcode 2 =

$$\begin{array}{r} 0100 \\ 1000 \\ \hline 0000 \end{array}$$

$\therefore$ The line is partially inside.

outcode 1 = 0100 != 0000

The outcode means it is below the clipping window.

For bottom intersection,

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{20 - (-30)}{5 - (-20)} = 2$$

$$y = y_{min} = -10$$

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

$$= -20 + \frac{1}{2}(-10 - (-30))$$

$$= -20 + \frac{1}{2}(20)$$

$$= -10$$

$x = -10$ $\quad x_{min} \le x \le x_{max}$ $\quad \therefore$ bit0 $= 0$ $\quad$ bit1 $= 0$

$y = -10$ $\quad y_{min} \le y \le y_{max}$ $\quad \therefore$ bit2 $= 0$ $\quad$ bit3 $= 0$

$\therefore$ outcode 1 $= 0000$

outcode 2 $= 1000$ $\ != 0000$

The outcode means it is above the clipping window.

For top intersection,

$$y = y_{max} = 10$$

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

$$= -20 + \frac{1}{2}(10 - (-30))$$

$$= -20 + \frac{1}{2}(40) = 0$$

Scanned with CamScanner

$\therefore x = 0 \quad x_{min} \leq x \leq x_{max} \quad \therefore bit0 = 0 \quad bit1 = 0$

$y = 10 \quad y_{min} \leq y \leq y_{max} \quad \therefore bit2 = 0 \quad bit3 = 0$

$\therefore$ outcode2 = 0000

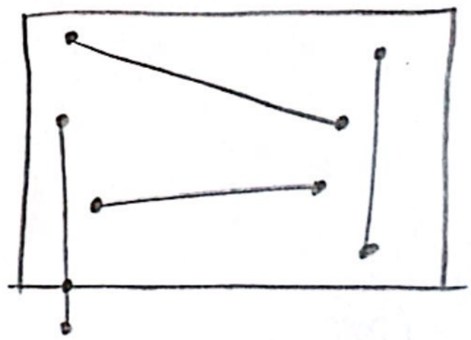
Now, outcode1 = outcode 2 = 0000 $\therefore$ Completely inside.

$\therefore$ line segment $(-10, -10)$ to $(0, 10)$ is now completely inside the clipping window.

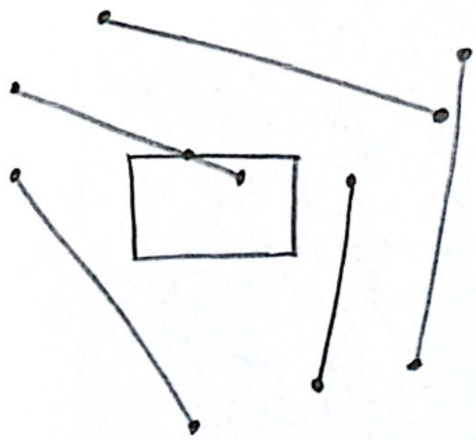
(b)

Cohen-Sutherland Algorithm works best in two scenarios.

(i) Very Large Clip Region: As many trivial points are accepted. Most line segments are completletely inside the clipping window, so very little clipping is required.



(ii) Very Small Clip Region: As many trivial points are rejected. Most line segments are completely outside the clipping window, so very little clipping is required.



Ans. to the Question No. 03

$$P' = [Shear]\ [T]\ [Scale]\ [Rotate]\ P$$

$$= [T_{(2,2)}]\ [Sh_{(8,7)}]\ [T_{(-2,-2)}]\ [T_{(20,10)}]\ [S_{(6,6)}]\ [T_{(5,5)}]\ [R_{(-30^\circ)}]\ [T_{(-5,-5)}]\ P$$

or,

$$\begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 8 & 0 \\ 7 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -2 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 20 \\ 0 & 1 & 10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 6 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 5 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos -30 & -\sin -30 & 0 \\ \sin -30 & \cos -30 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -5 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ 1 & 1 & 1 \end{bmatrix}$$

$\therefore$ Inverse Composite Transformation:

$$\begin{bmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 5 \\ 0 & 1 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -5 \\ 0 & 1 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/6 & 0 & 0 \\ 0 & 1/6 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -20 \\ 0 & 1 & -10 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -8 & 0 \\ -7 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -2 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cancel{0.866}\ \sqrt{3}/2 & -0.5 & 5 \\ 0.5 & \sqrt{3}/2 & 5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1/6 & 0 & -5 \\ 0 & 1/6 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -18 \\ 0 & 1 & -8 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -8 & 14 \\ -7 & 1 & 12 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0.1443 & -0.0833 & 3.17 \\ 0.0833 & 0.1443 & -1.83 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -8 & -4 \\ -7 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix}$$

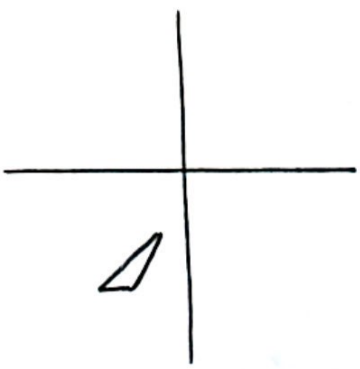
$$= \begin{bmatrix} 0.728 & -1.238 & 2.259 \\ -0.927 & -0.522 & -1.586 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 12 & 8 & 11 \\ 15 & 10 & 17 \\ 1 & 1 & 1 \end{bmatrix}$$

$$\therefore \begin{bmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} -7.58 & -4.3 & -10.783 \\ -20.545 & -14.226 & -20.663 \\ 1 & 1 & 1 \end{bmatrix}$$

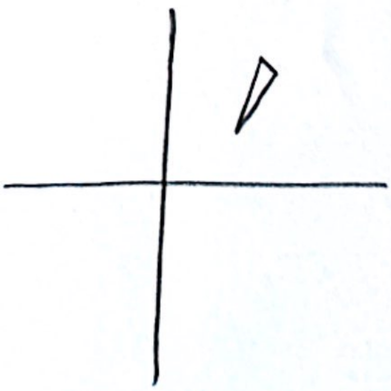
$\therefore$ Initial 3 vertices are $(-7.58, -20.545)$, $(-4.3, -14.226)$ and $(-10.783, -20.663)$.

At first Rotation is applied which is a Rigid-Body Transformation. So angles and distances are preserved, the Triangle remains a triangle.

Then Scaling is a Similitudes Transformation. So angles are preserved but distances are increased. The triangle becomes a bigger triangle.



Before Transformation



After Transformation

Then Translation is also a Rigid Body Transformation. So angles and distances are preserved. The big triangle remains a big triangle.

Finally, Shearing is linear Transformation. So the ~~pro~~ properties of a line are preserved. So the ratio of the distances is preserved but the angles become distorted. The triangle remains a triangle.

All of these are affine transformations. So, parallel lines remain parallel but the angles may end up distorted. Overall, the shape ~~retains~~ preserves its geometric properties of a triangle. ~~with its distances~~

~~max maintaining~~