EXPERIMENT 7

COMPUTER GRAPICS AND MULTIMEDIA

Aim

Write a C program to demonstrate Cohen Sutherland line clipping algorithm.

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EXPERIMENT - 7

AIM:

Write a C program to demonstrate Cohen Sutherland line clipping algorithm.

THEORY:

The Cohen–Sutherland algorithm is a computer-graphics algorithm used for line clipping. The algorithm divides a two-dimensional space into 9 regions and then efficiently determines the lines and portions of lines that are visible in the central region of interest (the viewport).

In the Cohen Sutherland line clipping algorithm, first of all, it is detected whether line lies inside the screen or it is outside the screen. All lines come under any one of the following categories:

1. Visible
2. Not Visible
3. Clipping Case

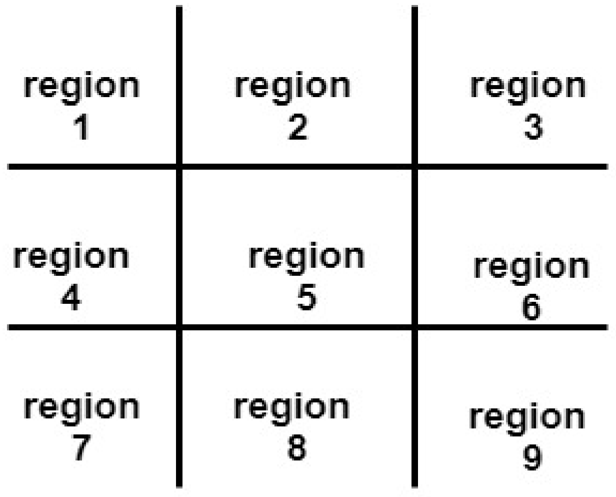
1. **Visible:** If a line lies within the window, i.e., both endpoints of the line lies within the window. A line is visible and will be displayed as it is.

2. **Not Visible:** If a line lies outside the window it will be invisible and rejected. Such lines will not display. If any one of the following inequalities is satisfied, then the line is considered invisible.

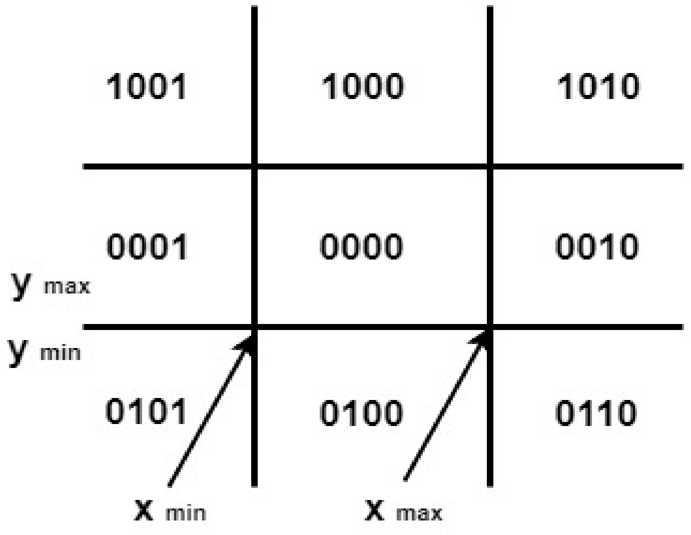
   Let A (x_1,y_2) and B (x_2,y_2) are endpoints of line.
   x_{min},x_{max} are coordinates of the window.
   y_{min},y_{max} are also coordinates of the window.

   $x_1>x_{max}$
   $x_2>x_{max}$
   $y_1>y_{max}$
   $y_2>y_{max}$
   $x_1<x_{min}$
   $x_2<x_{min}$
   $y_1<y_{min}$
   $y_2<y_{min}$

3. **Clipping Case:** If the line is neither visible case nor invisible case. It is considered to be clipped case. First of all, the category of a line is found based on nine regions given below. All nine regions are assigned codes. Each code is of 4 bits. If both endpoints of the line have end bits zero, then the line is considered to be visible.



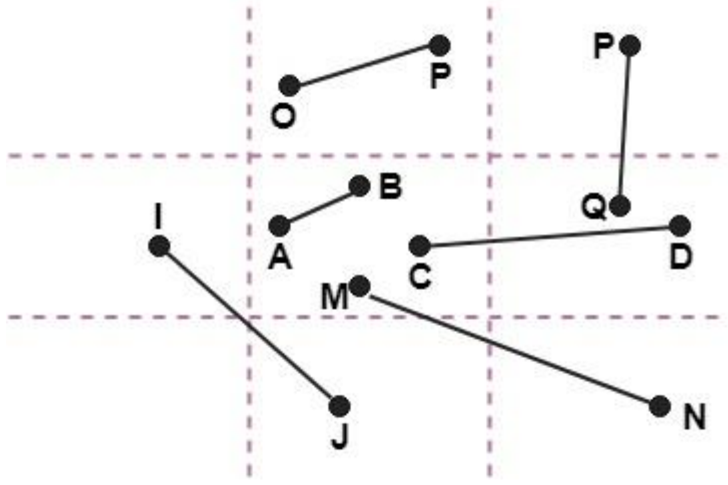
9 region



bits assigned to 9 regions

The center area is having the code, 0000, i.e., region 5 is considered a rectangle window.

Following figure show lines of various types



Line AB is the visible case
Line OP is an invisible case
Line PQ is an invisible line
Line IJ are clipping candidates
Line MN are clipping candidate
Line CD are clipping candidate

Advantage of Cohen Sutherland Line Clipping:

1. **It calculates end-points very quickly and rejects and accepts lines quickly.**
2. **It can clip pictures much large than screen size.**

Algorithm of Cohen Sutherland Line Clipping:

Step1: Calculate positions of both endpoints of the line.

Step2: Perform OR operation on both of these end-points.

Step3: If the OR operation gives 0000

```
    Then
        line is considered to be visible
    else
      Perform AND operation on both endpoints
   If And ≠ 0000
      then the line is invisible
    else
   And=0000
 Line is considered the clipped case.
```

Step4: If a line is clipped case, find an intersection with boundaries of the window

$m=(y_2-y_1)(x_2-x_1)$

(a) If bit 1 is "1" line intersects with left boundary of rectangle window

$y_3=y_1+m(x-X_1)$

where $X = X_{wmin}$

where $X_{wmin}$is the minimum value of X co-ordinate of window

(b) If bit 2 is "1" line intersect with right boundary

$y_3=y_1+m(X-X_1)$

where $X = X_{wmax}$

where X more is maximum value of X co-ordinate of the window

(c) If bit 3 is "1" line intersects with bottom boundary

$X_3=X_1+(y-y_1)/m$

where $y = y_{wmin}$

y_{wmin} is the minimum value of Y co-ordinate of the window

(d) If bit 4 is "1" line intersects with the top boundary

$X_{3=x}1+(y-y_1)/m$

where $y = y_{wmax}$

y_{wmax} is the maximum value of Y co-ordinate of the window

SOURCE CODE:

```
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
#include<graphics.h>
#include<dos.h>

typedef struct coordinate
{
	int x,y;
	char code[4];
}PT;

void drawwindow();
void drawline(PT p1,PT p2);
PT setcode(PT p);
int visibility(PT p1,PT p2);
PT resetendpt(PT p1,PT p2);

int main()
{
	PT p1,p2,p3,p4,ptemp;

	printf("\nEnter x1 and y1\n");
	scanf("%d %d",&p1.x,&p1.y);
	printf("\nEnter x2 and y2\n");
	scanf("%d %d",&p2.x,&p2.y);

	initwindow(800, 800);
	drawwindow();
	delay(500);
```

```
drawline(p1,p2);
delay(500);
cleardevice();

delay(500);
p1=setcode(p1);
p2=setcode(p2);
int v=visibility(p1,p2);
delay(500);

switch(v)
{
case 0: drawwindow();
            delay(500);
            drawline(p1,p2);
            break;
case 1:     drawwindow();
            delay(500);
            break;
case 2:     p3=resetendpt(p1,p2);
            p4=resetendpt(p2,p1);
            drawwindow();
            delay(500);
            drawline(p3,p4);
            break;
}

delay(5000);
getch();
closegraph();
return 0;
```

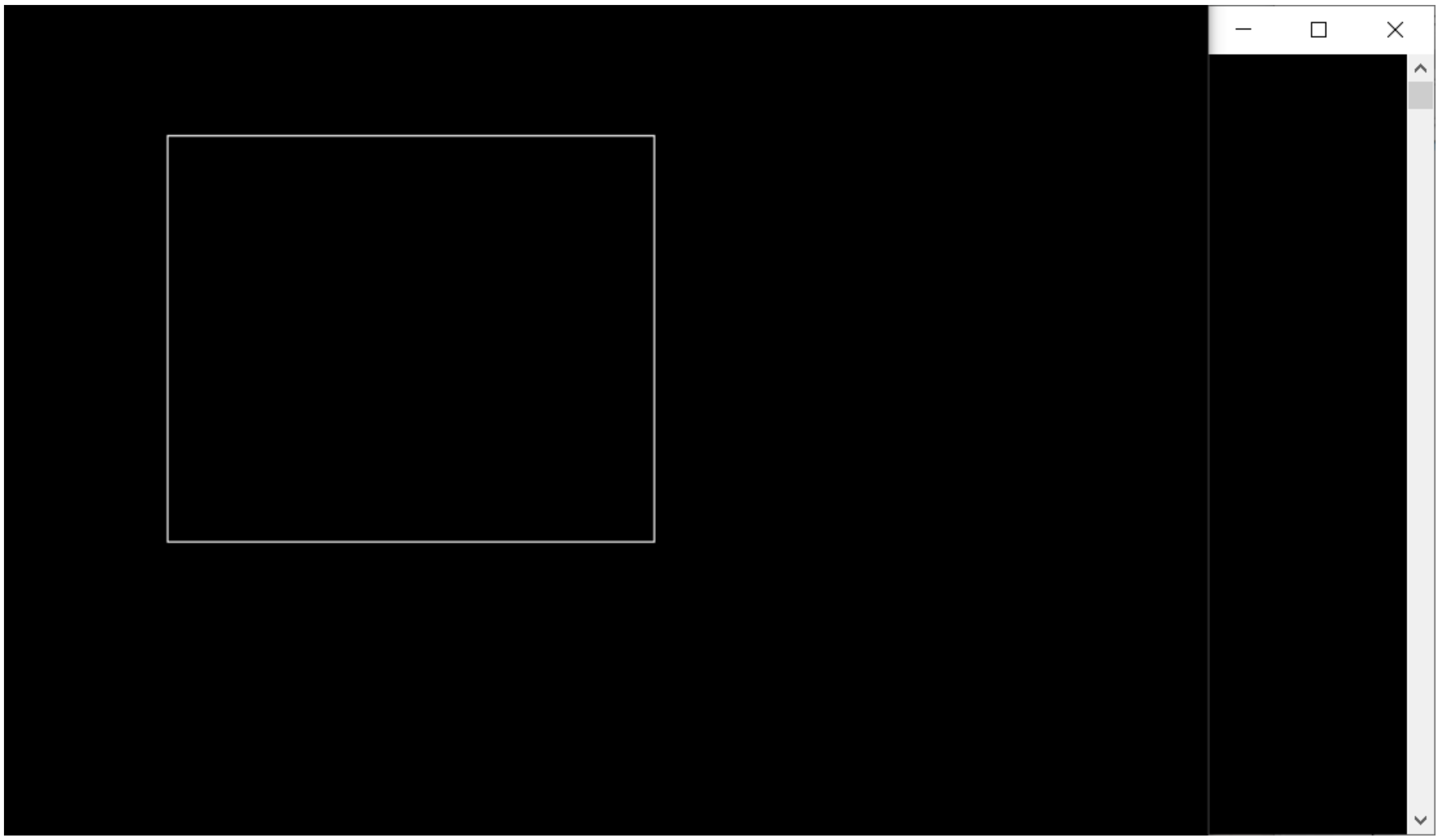
```
}

void drawwindow()
{
	line(150,100,450,100);
	line(450,100,450,350);
	line(450,350,150,350);
	line(150,350,150,100);
}

void drawline(PT p1,PT p2)
{
	line(p1.x,p1.y,p2.x,p2.y);
}

PT setcode(PT p)	//for setting the 4 bit code
{
	PT ptemp;

	if(p.y<100)
		ptemp.code[0]='1';  //Top

	else
		ptemp.code[0]='0';



	if(p.y>350)
		ptemp.code[1]='1';  //Bottom

	else
		ptemp.code[1]='0';
```

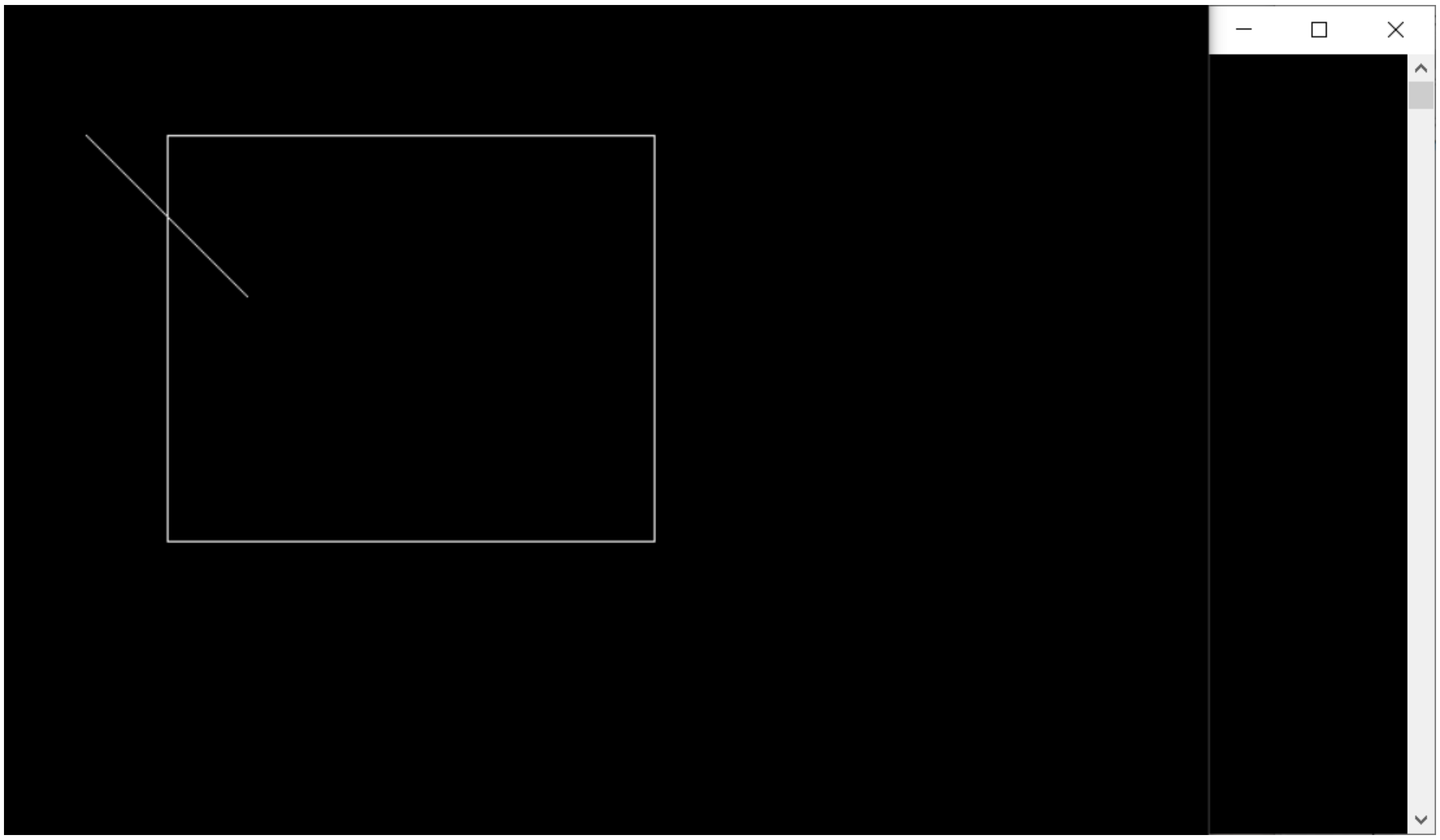
```
        if(p.x>450)
                ptemp.code[2]='1';  //Right

        else
                ptemp.code[2]='0';



        if(p.x<150)
                ptemp.code[3]='1';  //Left

        else
                ptemp.code[3]='0';

        ptemp.x=p.x;
        ptemp.y=p.y;

        return(ptemp);
}

int visibility(PT p1,PT p2)
{
        int i,flag=0;

        for(i=0;i<4;i++)
        {
                if((p1.code[i]!='0') || (p2.code[i]!='0'))
                        flag=1;
        }

        if(flag==0)
                return(0);
```

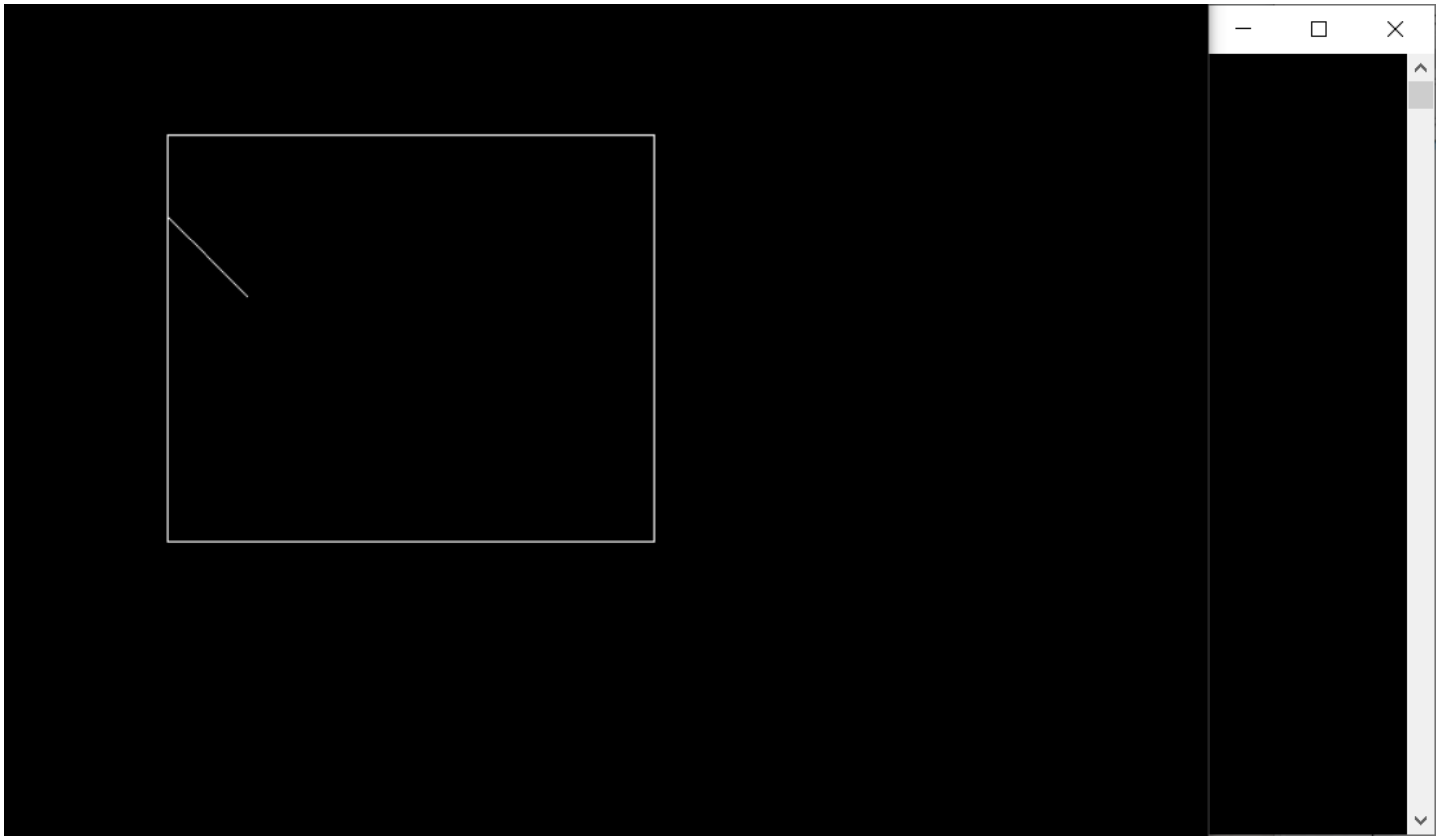
```
	for(i=0;i<4;i++)
	{
		if((p1.code[i]==p2.code[i]) && (p1.code[i]=='1'))
			flag='0';
	}

	if(flag==0)
		return(1);

	return(2);
}

PT resetendpt(PT p1,PT p2)
{
	PT temp;

	int x,y,i;
	float m,k;

	if(p1.code[3]=='1')
		x=150;

	if(p1.code[2]=='1')
		x=450;

	if((p1.code[3]=='1') || (p1.code[2]=='1'))
	{
		m=(float)(p2.y-p1.y)/(p2.x-p1.x);

		k=(p1.y+(m*(x-p1.x)));

		temp.y=k;
```

```
                temp.x=x;

                for(i=0;i<4;i++)
                        temp.code[i]=p1.code[i];

                if(temp.y<=350 && temp.y>=100)
                        return (temp);
        }

        if(p1.code[0]=='1')
                y=100;

        if(p1.code[1]=='1')
                y=350;

        if((p1.code[0]=='1') || (p1.code[1]=='1'))
        {
                m=(float)(p2.y-p1.y)/(p2.x-p1.x);
                k=(float)p1.x+(float)(y-p1.y)/m;
                temp.x=k;
                temp.y=y;

                for(i=0;i<4;i++)
                        temp.code[i]=p1.code[i];

                return(temp);
        }
        else
                return(p1);
}
```

OUTPUT:







VIVA Voice

Q1. what is advantage of Cohen Sutherland line clipping algorithm?

Ans.

1. It calculates end-points very quickly and rejects and accepts lines quickly.
2. It can clip pictures much large than screen size.

Q2. Use the cohen sutherland line clipping algorithm to clip line P1 (70,20) and P2(100,10) against a window lower left corner(50,10) and upper right corner(80,40).

Ans.

A line with starting point P & end point Q as the mid point

M1=((-10+50)/2   (20+10)/2)

M1=(20,15)

For line PM1:

Starting point	End point	Mid point	Location
(-10,20)	(50,10)	(20,15)	Inside

(-10,20)	(20,15)	(5,17.5)	Inside
(-10,20)	(5,17)	(2.5,18.5)	Inside
(-10,20)	(2,18)	(4,19)	Inside
(-10,20)	(4,19	(3,19.5)	Inside

For lineM1Q:

Starting point	End point	Mid point	Location
(20,15)	(50,10)	(35,12.5)	Inside
(20,15)	(35,12)	(27.5,13.5)	Inside
(20,15)	(27,13	(23.5,14)	Inside
(20,15)	(23,14)	(21.5,14.5)	Inside
(20,15)	(21,14)	(20.5,14.5)	Inside

Q3. What is the time and space complexity of Cohen Sutherland line clipping algorithm?

Ans.

1) Worst case time complexity: Θ(n)
2) Average case time complexity: Θ(n)
3) Best case time complexity: Θ(n)
4) Space complexity: Θ(1)

Q4. What do you understand by interior and exterior clipping?

Ans.

Clipping means Identifying portions of a scene that are inside (or outside) a specified region Examples Multiple viewport on a device Deciding how much of a games world the player can see.

In other words, Clipping is the process of removing the graphics parts either inside or outside the given region.

Interior clipping removes the parts outside the given window and exterior clipping removes the parts inside the given window.

Q5. What is the difference between a window and a viewport?

Ans.

Window Port	**Viewport**
Window port is the coordinate area specially selected for the display.	Viewport is the display area of viewport in which the window is perfectly mapped.
Region Created according to World Coordinates.	Region Created according to Device Coordinates.
It is a region selected form the real world. It is a graphically control thing and composed of visual areas along with some of its program controlled with help of window decoration.	It is the region in computer graphics which is a polygon viewing region.
A window port can be defined with the help of a GWINDOW statement.	A viewport is defined by the GPORT command.

Q6. What are the different types of clipping algorithms?

Ans.

There are five primitive types clipping, such as point, line, polygon or are, curve and text clipping. Classical line clipping algorithms includes Cohen–Sutherland algorithm, Midpoint Subdivision algorithm, Liang Bearsky and Nicholl-Lee-Nicholl algorithm.