UNIT 1
INTRODUCTION TO COMPUTER GRAPHICS

Computer Graphics

Computer Graphics is the creation of pictures with the help of a computer. The end product of the computer graphics is a picture it may be a business graph, drawing, and engineering. In computer graphics, two or three-dimensional pictures can be created that are used for research.

Display Devices in Computer Graphics

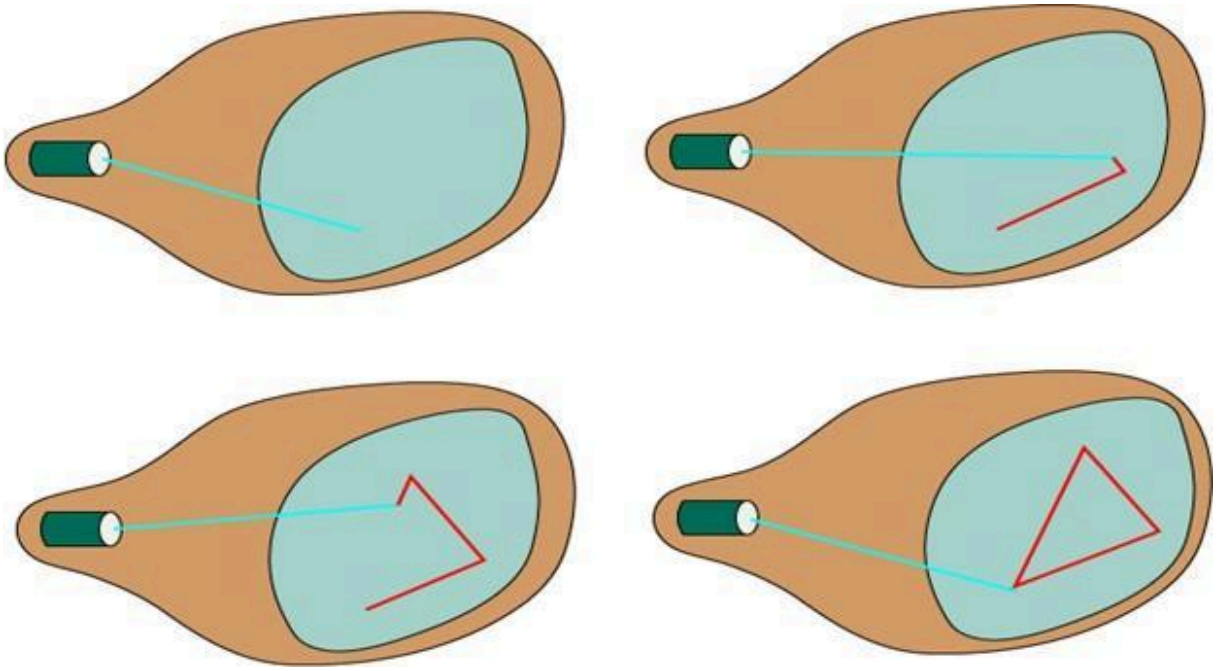
- Cathode-Ray Tube(CRT)
- Color CRT Monitor.

Display devices in graphics

The display device is an output device used to represent the information in the form of images (visual form). Display systems are mostly called a video monitor or Video display unit (VDU).
Display devices are designed to model, display, view, or display information. The purpose of display technology is to simplify information sharing.

Random Scan Display:

Random Scan System uses an electron beam which operates like a pencil to create a line image on the CRT screen. The picture is constructed out of a sequence of straight-line segments. Each line segment is drawn on the screen by directing the beam to move from one point on the screen to the next, where its x & y coordinates define each point. After drawing the picture. The system cycles back to the first line and design all the lines of the image 30 to 60 time each second. The process is shown in fig:



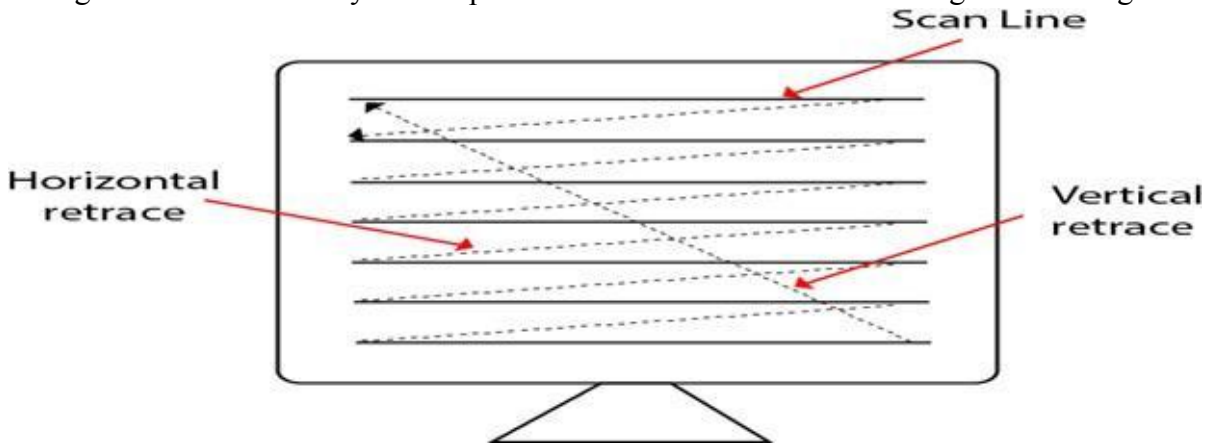
Random-scan monitors are also known as vector displays or stroke-writing displays or calligraphic displays.

Raster Scan Display:

A Raster Scan Display is based on intensity control of pixels in the form of a rectangular box called Raster on the screen. Information of on and off pixels is stored in refresh buffer or Frame buffer. Televisions in our house are based on Raster Scan Method. The raster scan system can store information of each pixel position, so it is suitable for realistic display of

objects. Raster Scan provides a refresh rate of 60 to 80 frames per second.

Frame Buffer is also known as Raster or bit map. In Frame Buffer the positions are called picture elements or pixels. Beam refreshing is of two types. First is horizontal retracing and second is vertical retracing. When the beam starts from the top left corner and reaches the bottom right scale, it will again return to the top left side called at vertical retrace. Then it will again more horizontally from top to bottom call as horizontal retracing shown in fig:



Types of Scanning or travelling of beam in Raster Scan

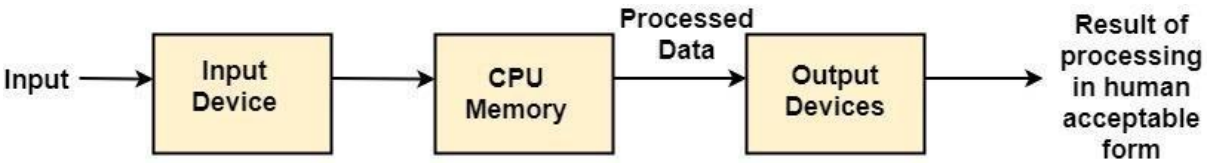
1. Interlaced Scanning
2. Non-Interlaced Scanning

In Interlaced scanning, each horizontal line of the screen is traced from top to bottom. Due to which fading of display of object may occur. This problem can be solved by Non-Interlaced scanning. In this first of all odd numbered lines are traced or visited by an electron beam, then in the next circle, even number of lines are located.
For non-interlaced display refresh rate of 30 frames per second used. But it gives flickers. For interlaced display refresh rate of 60 frames per second is used.

Random Scan	**Raster Scan**
It has high Resolution	Its resolution is low.
It is more expensive	It is less expensive
Any modification if needed is easy	Modification is tough
Solid pattern is tough to fill	Solid pattern is easy to fill
Refresh rate depends or resolution	Refresh rate does not depend on the picture
Only screen with view on an area is displayed	Whole screen is scanned
Beam Penetration technology come under it.	Shadow mark technology came under this
It does not use interlacing method.	It uses interlacing
It is restricted to line drawing applications	It is suitable for realistic display

Input Devices

The Input Devices are the hardware that is used to transfer transfers input to the computer. The data can be in the form of text, graphics, sound, and text. Output device display data from the memory of the computer. Output can be text, numeric data, line, polygon, and other objects.



These Devices include:

1. Keyboard
2. Mouse
3. Trackball
4. Spaceball
5. Joystick
6. Light Pen
7. Digitizer
8. Touch Panels
9. Voice Recognition
10. Image Scanner

Keyboard:

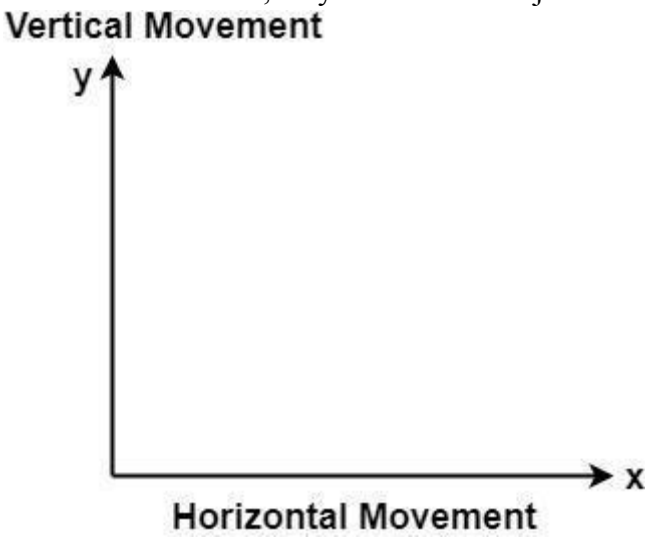
The most commonly used input device is a keyboard. The data is entered by pressing the set of keys. All keys are labeled. A keyboard with 101 keys is called a QWERTY keyboard.
The keyboard has alphabetic as well as numeric keys. Some special keys are also available.

1. **Numeric Keys:** 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
2. **Alphabetic keys:** a to z (lower case), A to Z (upper case)
3. **Special Control keys:** Ctrl, Shift, Alt
4. **Special Symbol Keys:** ; , " ? @ ~ ? :
5. **Cursor Control Keys:** ↑ → ← ↓
6. **Function Keys:** F1 F2 F3. F9.
7. **Numeric Keyboard:** It is on the right-hand side of the keyboard and used for fast entry of numeric data.

Mouse:

A Mouse is a pointing device and used to position the pointer on the screen. It is a small palm size box. There are two or three depression switches on the top. The movement of the mouse along the x-axis helps in the horizontal movement of the cursor and the movement along the

y-axis helps in the vertical movement of the cursor on the screen. The mouse cannot be used to enter text. Therefore, they are used in conjunction with a keyboard.



Trackball

It is a pointing device. It is similar to a mouse. This is mainly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted, and by changing fingers on the ball, the pointer can be moved.

Spaceball:

It is similar to trackball, but it can move in six directions where trackball can move in two directions only. The movement is recorded by the strain gauge. Strain gauge is applied with pressure. It can be pushed and pulled in various directions. The ball has a diameter around 7.5 cm. The ball is mounted in the base using rollers. One-third of the ball is an inside box, the rest is outside.

Joystick:

A Joystick is also a pointing device which is used to change cursor position on a monitor screen. Joystick is a stick having a spherical ball as its both lower and upper ends as shown in fig. The lower spherical ball moves in a socket. The joystick can be changed in all four directions. The function of a joystick is similar to that of the mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

Light Pen:

Light Pen (similar to the pen) is a pointing device which is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube. When its tip is moved over the monitor screen, and pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signals to the CPU.

Digitizers:

The digitizer is an operator input device, which contains a large, smooth board (the appearance is similar to the mechanical drawing board) & an electronic tracking device, which can be changed over the surface to follow existing lines. The electronic tracking device contains a switch for the user to record the desire x & y coordinate positions. The coordinates can be entered into the computer memory or stored or an off-line storage medium such as magnetic tape.

Touch Panels:

Touch Panels is a type of display screen that has a touch-sensitive transparent panel covering the screen. A touch screen registers input when a finger or other object comes in contact with the screen.When the wave signals are interrupted by some contact with the screen, that located is recorded. Touch screens have long been used in military applications.

Voice Systems (Voice Recognition):

Voice Recognition is one of the newest, most complex input techniques used to interact with the computer. The user inputs data by speaking into a microphone. The simplest form of voice recognition is a one-word command spoken by one person. Each command is isolated with pauses between the words.

Voice Recognition is used in some graphics workstations as input devices to accept voice commands. The voice-system input can be used to initiate graphics operations or to enter data.

Image Scanner:

It is an input device. The data or text is written on paper. The paper is feeded to scanner. The paper written information is converted into electronic format; this format is stored in the computer. The input documents can contain text, handwritten material, picture extra.

By storing the document in a computer document became safe for longer period of time. The document will be permanently stored for the future. We can change the document when we need. The document can be printed when needed.

Scanning can be of the black and white or colored picture. On stored picture 2D or 3D rotations, scaling and other operations can be applied.

Output Devices

It is an electromechanical device, which accepts data from a computer and translates them into form understand by users.

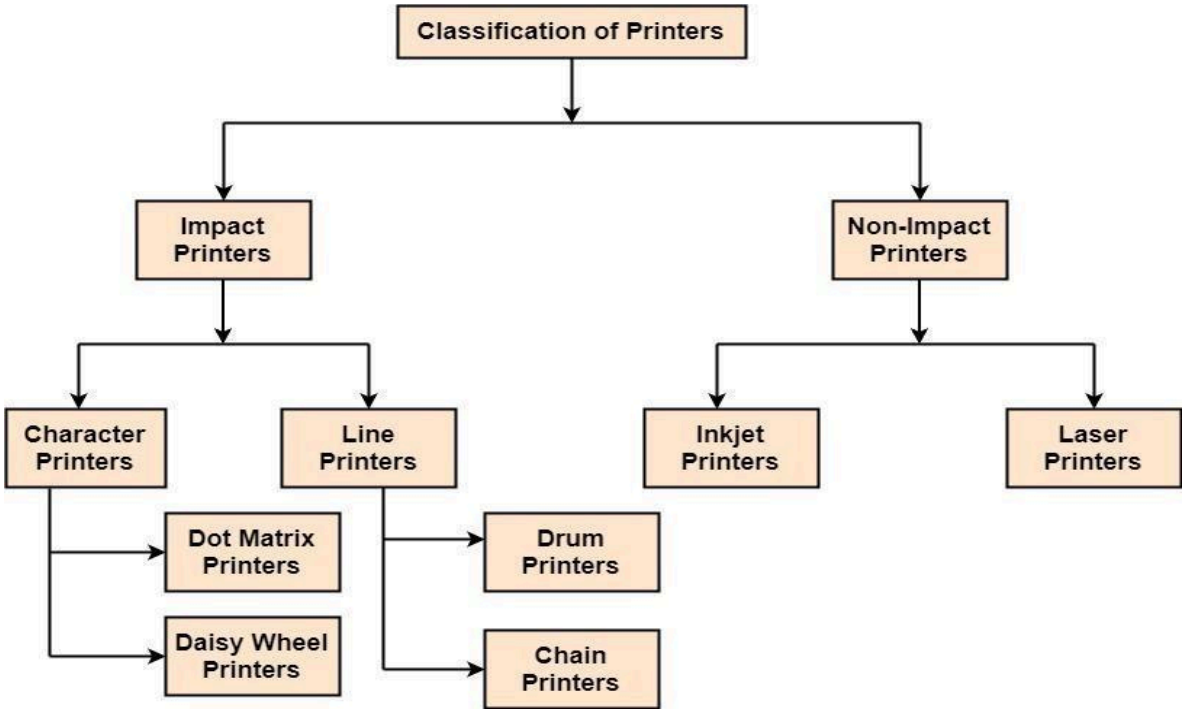
Following are Output Devices:

1. Printers
2. Plotters

Printers:

Printer is the most important output device, which is used to print data on paper.

Types of Printers: There are many types of printers which are classified on various criteria as shown in fig:



1. **Impact Printers:** The printers that print the characters by striking against the ribbon and onto the papers are known as Impact Printers.

These Printers are of two types:

1. Character Printers
2. Line Printers

2. **Non-Impact Printers:** The printers that print the characters without striking against the ribbon and onto the papers are called Non-Impact Printers. These printers print a complete page at a time, therefore, also known as Page Printers.

Page Printers are of two types:

1. Laser Printers
2. Inkjet Printers

Dot Matrix Printers:

Dot matrix has printed in the form of dots. A printer has a head which contains nine pins. The nine pins are arranged one below other. Each pin can be activated independently. All or only the same needles are activated at a time. When needless is not activated, and then the tip of needle stay in the head. When pin work, it comes out of the print head. In nine pin printer, pins are arranged in 5 * 7 matrixes.

Advantage:

1. Dot Matrix Printers prints output as dots, so it can print any shape of the character. This allows the printer to print special character, charts, graphs, etc.
2. Dot Matrix Printers come under the category of impact printers. The printing is done when the hammer pin strikes the inked ribbon. The impressions are printed on paper. By placing multiple copies of carbon, multiple copies of output can be produced.
3. It is suitable for printing of invoices of companies.

Daisy Wheel Printers:

Head is lying on a wheel and Pins corresponding to characters are like petals of Daisy, that's why called Daisy wheel printer.



Daisy Wheel Printer

Advantage:

1. More reliable than DMPs
2. Better Quality

Disadvantage:

1. Slower than DMPs

Drum Printers:

These are line printers, which prints one line at a time. It consists of a drum. The shape of the drum is cylindrical. The drum is solid and has characters embossed on it in the form of vertical bands. The characters are in circular form. Each band consists of some characters. Each line on drum consists of 132 characters. Because there are 96 lines so total characters are (132 * 95) = 12, 672.
Drum contains a number of hammers also.

Chain Printers:

These are called as line printers. These are used to print one line at a line. Basically, chain consists of links. Each link contains one character. Printers can follow any character set style, i.e., 48, 64 or 96 characters. Printer consists of a number of hammers also.

Advantages:

1. Chain or Band if damaged can be changed easily.
2. It allows printing of different form.
3. Different Scripts can be printed using this printer.

Disadvantages:

1. It cannot print charts and graphs.
2. It cannot print characters of any shape.
3. Chain Printers is impact printer, hammer strikes so it is noisy.

Non-Impact Printers:

Inkjet Printers:

These printers use a special link called electrostatic ink. The printer head has a special nozzle. Nozzle drops ink on paper. Head contains up to 64 nozzles. The ink dropped is deflected by the electrostatic plate. The plate is fixed outside the nozzle. The deflected ink settles on paper.



Inkjet Printer

Advantages:

1. These produce high quality of output as compared to the dot matrix.
2. A high-quality output can be produced using 64 nozzles printed.
3. Inkjet can print characters in a variety of shapes.
4. Inkjet can print special characters.
5. The printer can print graphs and charts.

Disadvantages:

1. Inkjet Printers are slower than dot matrix printers.
2. The cost of inkjet is more than a dot matrix printer.

Laser Printers:

These are non-impact page printers. They use laser lights to produces the dots needed to form the characters to be printed on a page & hence the name laser printers.

The output is generated in the following steps:

Step 1: The bits of data sent by processing unit act as triggers to turn the laser beam on & off.

Step 2: The output device has a drum which is cleared & is given a positive electric charge. To print a page the modulated laser beam passing from the laser scans back & forth the surface of the drum. The positive electric charge on the drum is stored on just those parts of the drum surface which are exposed to the laser beam create the difference in electric which charges on the exposed drum surface.

Step 3: The laser parts of the drum attract an ink powder known as toner.

Step 4: The attracted ink powder is transferred to paper.

Step 5: The ink particles are permanently fixed to the paper by using either heat or pressure technique.

Step 6: The drum rotates back to the cleaner where a rubber blade cleans off the excess ink & prepares the drum to print the next page.

Plotters

Plotters are a special type of output device. It is suitable for applications:

1. Architectural plan of the building.
2. CAD applications like the design of mechanical components of aircraft.
3. Many engineering applications.

Advantage:

1. It can produce high-quality output on large sheets.
2. It is used to provide the high precision drawing.
3. It can produce graphics of various sizes.
4. The speed of producing output is high.

Drum Plotter:

It consists of a drum. Paper on which design is made is kept on the drum. The drum can rotate in both directions. Plotters comprised of one or more pen and penholders. The holders are mounted perpendicular to drum surface. The pens are kept in the holder, which can move

left to the right as well as right to the left. The graph plotting program controls the movement of pen and drum.

Flatbed Plotter:

It is used to draw complex design and graphs, charts. The Flatbed plotter can be kept over the table. The plotter consists of pen and holder. The pen can draw characters of various sizes. There can be one or more pens and pen holding mechanism. Each pen has ink of different color.

Different colors help to produce multicolor design of document. The area of plotting is also variable. It can vary A4 to 21'*52'.

1. Cars
2. Ships
3. Airplanes
4. Shoe and dress designing
5. Road and highway design

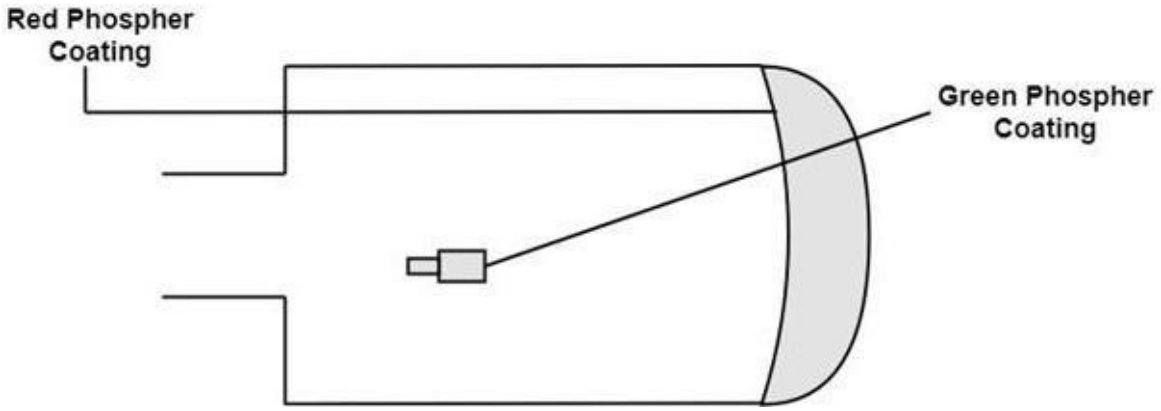
Color CRT Monitors:

The CRT Monitor display by using a combination of phosphors. The phosphors are different colors. There are two popular approaches for producing color displays with a CRT are:

1. Beam Penetration Method
2. Shadow-Mask Method

1. Beam Penetration Method:

The Beam-Penetration method has been used with random-scan monitors. In this method, the CRT screen is coated with two layers of phosphor, red and green and the displayed color depends on how far the electron beam penetrates the phosphor layers. This method produces four colors only, red, green, orange and yellow. A beam of slow electrons excites the outer red layer only; hence screen shows red color only. A beam of high-speed electrons excites the inner green layer. Thus screen shows a green color.



Advantages:

1. Inexpensive

Disadvantages:

1. Only four colors are possible
2. Quality of pictures is not as good as with another method.

2. Shadow-Mask Method:

- Shadow Mask Method is commonly used in Raster-Scan System because they produce a much wider range of colors than the beam-penetration method.
- It is used in the majority of color TV sets and monitors.

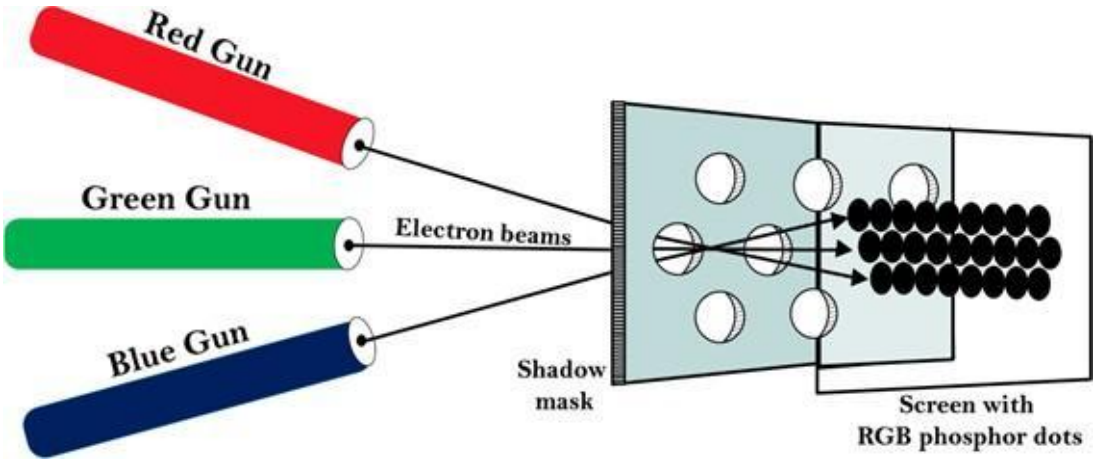
Construction: A shadow mask CRT has 3 phosphor color dots at each pixel position.

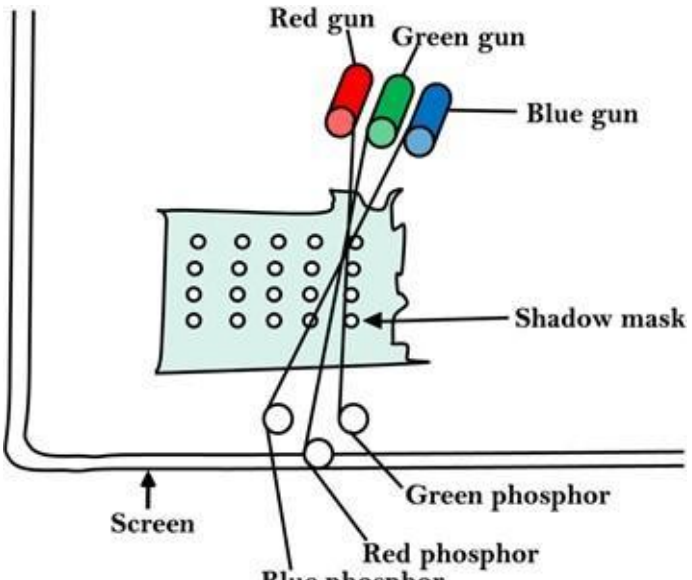
- One phosphor dot emits: red light
- Another emits: green light
- Third emits: blue light

This type of CRT has 3 electron guns, one for each color dot and a shadow mask grid just behind the phosphor coated screen.

Shadow mask grid is pierced with small round holes in a triangular pattern.

Figure shows the delta-delta shadow mask method commonly used in color CRT system.





Working: Triad arrangement of red, green, and blue guns.
The deflection system of the CRT operates on all 3 electron beams simultaneously; the 3 electron beams are deflected and focused as a group onto the shadow mask, which contains a sequence of holes aligned with the phosphor- dot patterns.

When the three beams pass through a hole in the shadow mask, they activate a dotted triangle, which occurs as a small color spot on the screen.
The phosphor dots in the triangles are organized so that each electron beam can activate only its corresponding color dot when it passes through the shadow mask.
Inline arrangement: Another configuration for the 3 electron guns is an Inline arrangement in which the 3 electron guns and the corresponding red-green-blue color dots on the screen, are aligned along one scan line rather of in a triangular pattern.
This inline arrangement of electron guns in easier to keep in alignment and is commonly used in high-resolution color CRT's.

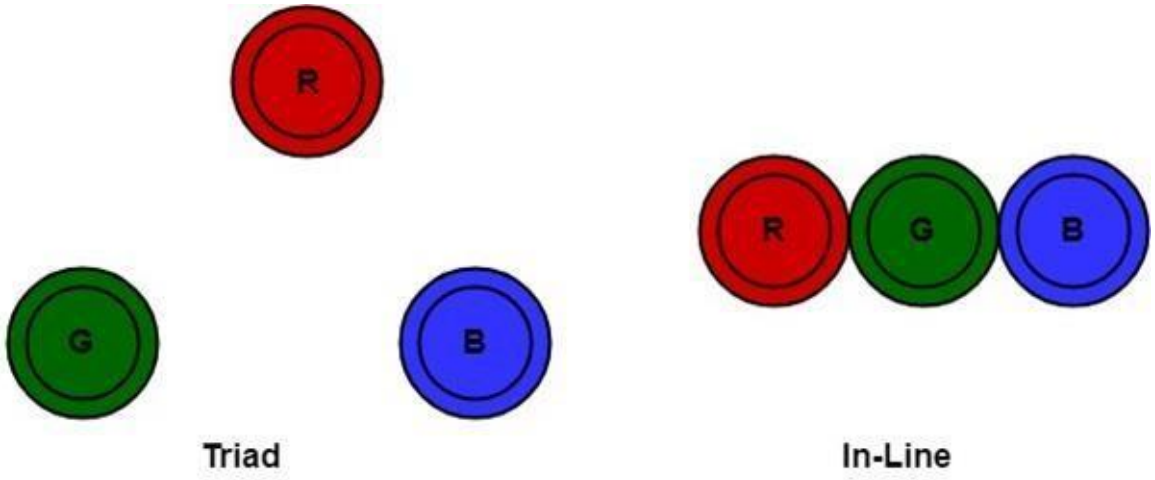


Fig: Triad-and -in-line arrangements of red, green and blue electron guns of CRT for color monitors.

Advantage:

1. Realistic image
2. Million different colors to be generated
3. Shadow scenes are possible

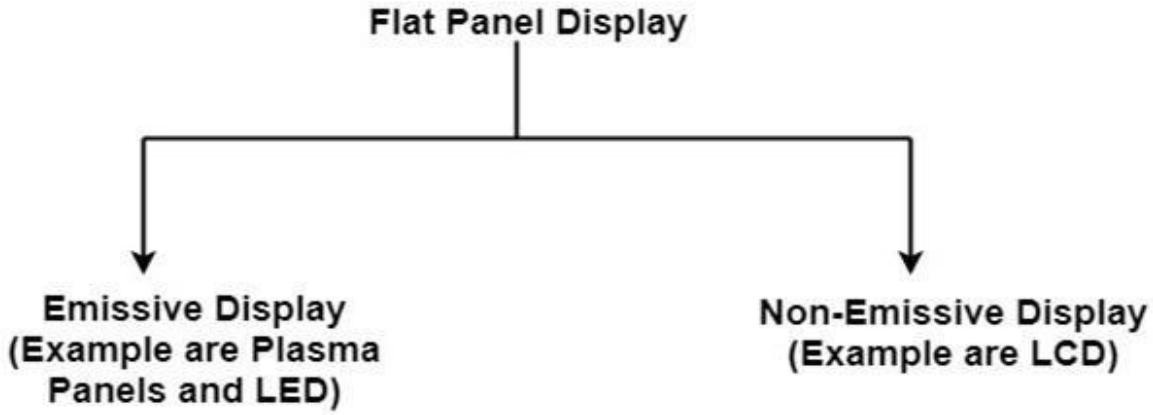
Disadvantage:

1. Relatively expensive compared with the monochrome CRT.
2. Relatively poor resolution
3. Convergence Problem

Flat Panel Display:

The Flat-Panel display refers to a class of video devices that have reduced volume, weight and power requirement compare to CRT.
Example: Small T.V. monitor, calculator, pocket video games, laptop computers, an advertisement board in elevator.

1. **Emissive Display:** The emissive displays are devices that convert electrical energy into light. Examples are Plasma Panel, thin film electroluminescent display and LED (Light Emitting Diodes).
2. **Non-Emissive Display:** The Non-Emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. Examples are LCD (Liquid Crystal Device).



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Plasma Panel Display:

Plasma-Panels are also called as Gas-Discharge Display. It consists of an array of small lights. Lights are fluorescent in nature. The essential components of the plasma-panel display are:

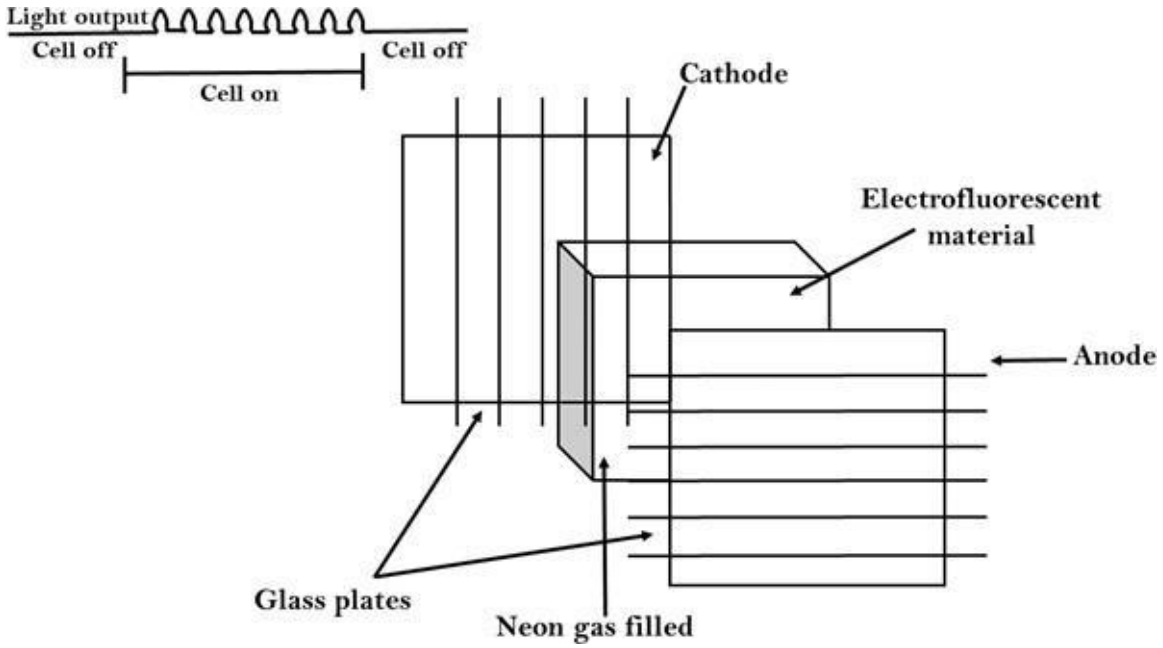
1. **Cathode:** It consists of fine wires. It delivers negative voltage to gas cells. The voltage is released along with the negative axis.
2. **Anode:** It also consists of line wires. It delivers positive voltage. The voltage is supplied along positive axis.
3. **Fluorescent cells:** It consists of small pockets of gas liquids when the voltage is applied to this liquid (neon gas) it emits light.
4. **Glass Plates:** These plates act as capacitors. The voltage will be applied, the cell will glow continuously.

The gas will slow when there is a significant voltage difference between horizontal and vertical wires. The voltage level is kept between 90 volts to 120 volts. Plasma level does not require refreshing. Erasing is done by reducing the voltage to 90 volts.

Each cell of plasma has two states, so cell is said to be stable. Displayable point in plasma

panel is made by the crossing of the horizontal and vertical grid. The resolution of the plasma panel can be up to 512 * 512 pixels.

Figure shows the state of cell in plasma panel display:



Advantage:

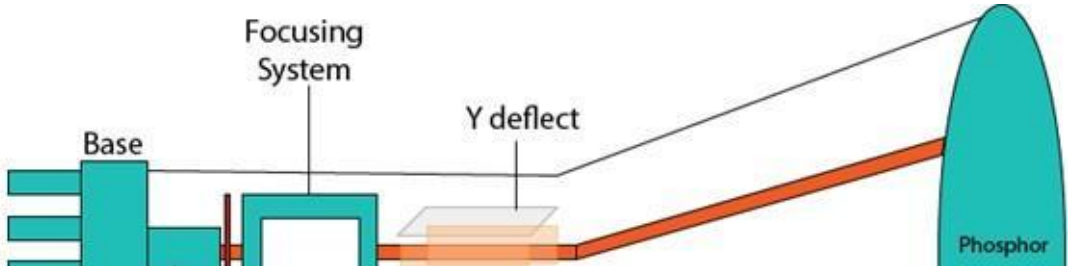
1. High Resolution
2. Large screen size is also possible.
3. Less Volume
4. Less weight
5. Flicker Free Display

Disadvantage:

1. Poor Resolution
2. Wiring requirement anode and the cathode is complex.
3. Its addressing is also complex.

Cathode Ray Tube (CRT):

CRT stands for Cathode Ray Tube. CRT is a technology used in traditional computer monitors and televisions. The image on CRT display is created by firing electrons from the back of the tube of phosphorus located towards the front of the screen.
Once the electron heats the phosphorus, they light up, and they are projected on a screen. The color you view on the screen is produced by a blend of red, blue and green light.



Components of CRT:

Main Components of CRT are:

1. **Electron Gun:** Electron gun consisting of a series of elements, primarily a heating filament (heater) and a cathode. The electron gun creates a source of electrons which are focused into a narrow beam directed at the face of the CRT.
2. **Control Electrode:** It is used to turn the electron beam on and off.
3. **Focusing system:** It is used to create a clear picture by focusing the electrons into a narrow beam.
4. **Deflection Yoke:** It is used to control the direction of the electron beam. It creates an electric or magnetic field which will bend the electron beam as it passes through the area. In a conventional CRT, the yoke is linked to a sweep or scan generator. The deflection yoke which is connected to the sweep generator creates a fluctuating electric or magnetic potential.
5. **Phosphorus-coated screen:** The inside front surface of every CRT is coated with phosphors. Phosphors glow when a high-energy electron beam hits them. Phosphorescence is the term used to characterize the light given off by a phosphor after it has been exposed to an electron beam.

UNIT 2
GRAPHICS ALGORITHM

DDA Algorithm

DDA stands for Digital Differential Analyzer. It is an incremental method of scan conversion of line. In this method calculation is performed at each step but by using results of previous steps.

Advantage:

It is a faster method than method of using direct use of line equation. This method does not use multiplication theorem.
It allows us to detect the change in the value of x and y ,so plotting of same point twice is not possible. This method gives overflow indication when a point is repositioned.
It is an easy method because each step involves just two additions. **Disadvantage:**
It involves floating point additions rounding off is done. Accumulations of round off error cause accumulation of error.
Rounding off operations and floating point operations consumes a lot of time.
It is more suitable for generating line using the software. But it is less suited for hardware implementation.

DDA Algorithm:

Step 1: Start Algorithm
Step 2: Declare x1,y1,x2,y2,dx,dy,x,y as integer variables.
Step 3: Enter value of x1,y1,x2,y2.
Step 4: Calculate dx = x2-x1
Step 5: Calculate dy = y2-y1
Step 6: If ABS (dx) >

ABS (dy) Then step =

abs (dx)

Else
Step 7:

xinc=dx/step

yinc=dy/step

assign x

= x1

assign y

= y1

Step 8: Set pixel (x, y)
Step 9: x = x

+ xinc y = y

+ yinc

Set pixels (Round (x), Round (y))
Step 10: Repeat step 9 until x = x2
Step 11: End Algorithm
Example: If a line is drawn from (2, 3) to (6, 15) with use of DDA. How many points will needed to generate such line?
Solution: P1 (2,3) P11 (6,15)
x

1

=

2

y

1

=

3

x

2

=

6

y

2

=

5

dx = 6 - 2 = 4

dy = 15 - 3 = 12

m = DDA Algorithm

For calculating next value of x takes x = x + DDA Algorithm

DDA Algorithm

Program to implement DDA Line Drawing

```
#include<graphics.h>

#include<conio.h>
#include<stdi

o.h>       void

main()

{

intgd              =

DETECT ,gm, i;

float              x,

y,dx,dy,steps; int

x0, x1, y0, y1;

initgraph(&gd, &gm,

"C:\\TC\\BGI");

setbkcolor(WHITE);

x0 = 100 , y0 = 200, x1 = 500, y1 = 300;

dx = (float)(x1 - x0);

dy = (float)(y1

- y0);

if(dx>=dy)

{

steps = dx;
```

```
}
else
{
steps = dy;
}
dx = dx/steps;
dy = dy/steps;
x = x0;
y = y0; i = 1;
while(i<= steps)
{
putpixel(x, y, RED); x += dx;
y += dy;
i=i +1;
}
getch();
closegra ph();
}
```

Output:



Bresenham's Line Algorithm

This algorithm is used for scan converting a line. It was developed by Bresenham. It is an efficient method because it involves only integer addition, subtractions, and multiplication operations. These operations can be performed very rapidly so lines can be generated quickly.
In this method, next pixel selected is that one who has the least distance from true

line.

Advantage:

1. It involves only integer arithmetic, so it is simple.
2. It avoids the generation of duplicate points.
3. It can be implemented using hardware because it does not use multiplication and division.
4. It is faster as compared to DDA (Digital Differential Analyzer) because it does not involve floating point calculations like DDA Algorithm.

Disadvantage:

1. This algorithm is meant for basic line drawing only Initializing is not a part of Bresenham's line algorithm. So to draw smooth lines, you should want to look into a different algorithm.

Bresenham's Line Algorithm:

Step 1: Start Algorithm

Step 2: Declare variable
$x_1, x_2, y_1, y_2, d, i_1, i_2, dx, dy$

Step 3: Enter value of x_1, y_1, x_2, y_2
Where x_1, y_1 are coordinates of starting point And x_2, y_2 are coordinates of Ending point

Step 4: Calculate $dx = x_2 - x_1$
Calculate $dy = y_2 - y_1$ Calculate $i_1 = 2*dy$ Calculate $i_2 = 2*(dy-dx)$
Calculate $d = i_1 - dx$

Step 5: Consider (x, y) as starting point and x_{end} as maximum possible value of x.
If $dx < 0$
Then x $= x_2$ y $= y_2$
$x_{end} = x_1$
If $dx > 0$
Then x $= x_1$

y = y_1

x_{end}=x_2

Step 6: Generate point at (x,y)coordinates.

Step 7: Check if whole line is generated.

If x > =

x_{end}

Stop.

Step 8: Calculate co-ordinates of the next pixel If d < 0

Then d = d + i_1 If d ≥ 0

Then d = d + i_2

Increment y = y + 1

Step 9: Increment x = x + 1

Step 10: Draw a point of latest (x, y) coordinates

Step 11: Go to step 7

Step 12: End of Algorithm

Example: Starting and Ending position of the line are (1, 1) and (8, 5). Find intermediate points.

Solution: x_1=1

y_1 = 1

x_2 = 8

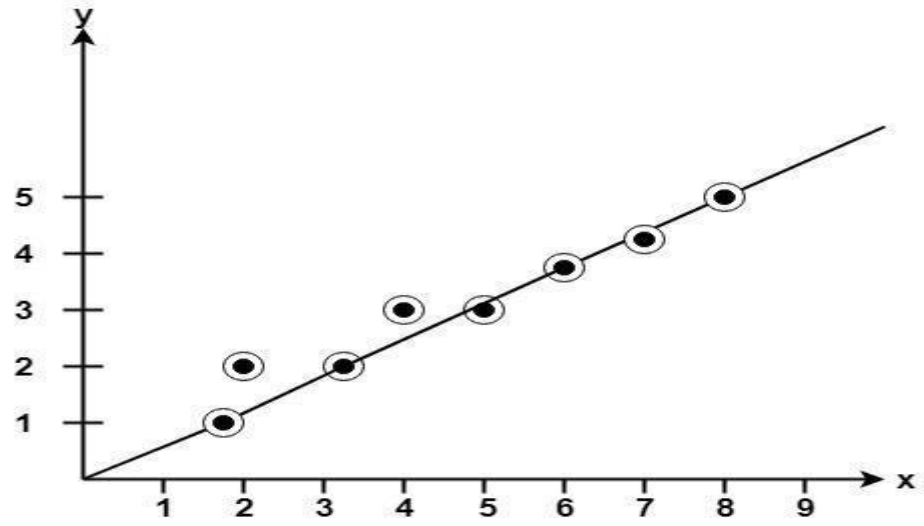
y_2 = 5

dx= x_2-x_1=8-1=7

dy=y_2-y_1=5-1=4

I_1=2* Δy=2*4=8

I_2=2*(Δy-Δx)=2*(4-7)=-6 d = I_1-Δx=8-7=1

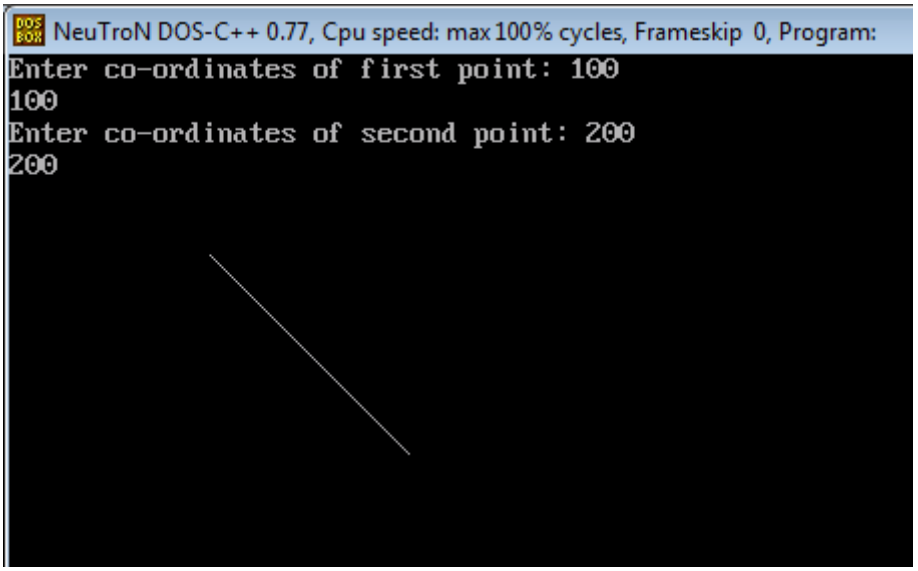


Program to implement Bresenham's Line Drawing Algorithm:

```
1.  #include<stdio.h>
2.  #include<graphics.h>
3.      void drawline(int x0, int y0, int
x1, int y1) 4. {
5. int dx, dy, p, x, y;
6.  dx=x1-x0;
7.  dy=y1-y0;
8.  x=x0;
9.  y=y0;
10. p=2*dy-dx;
11. while(x<x1)
12. {
13. if(p>=0)
14. {
15.
putpixel(x,y,7);
16. y=y+1;
17. p=p+2*dy-2*dx;
18. }
19. else
20. {
21. putpixel(x,y,7);
22.
p=p+2*dy;}
23. x=x+1;
24. }
25. }
```

```
26. int main()
27. {
28. int gdriver=DETECT, gmode, error, x0, y0, x1, y1;
29. initgraph(&gdriver, &gmode, "c:\\turboc3\\bgi");
30. printf("Enter co-ordinates of first point: ");
31. scanf("%d%d", &x0, &y0);
32. printf("Enter co-ordinates of second point: ");
33. scanf("%d%d", &x1, &y1);
34. drawline(x0, y0, x1, y1);
35. return 0;
36. }
```

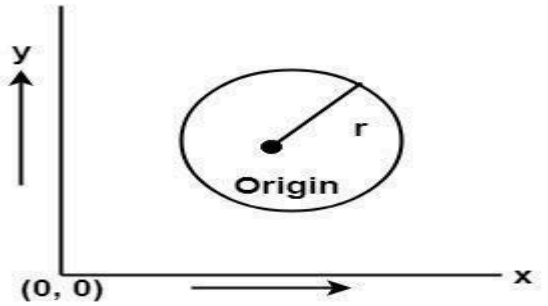
Output:



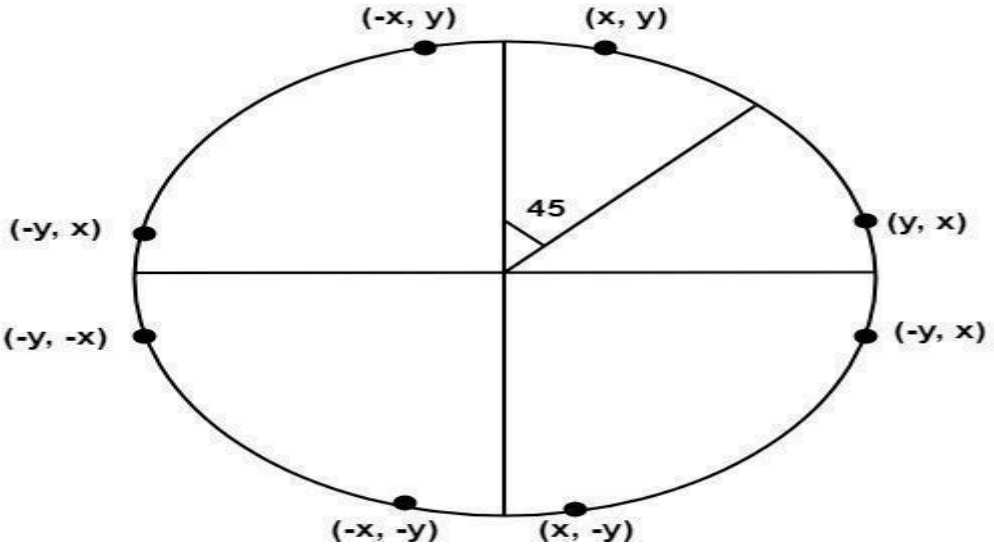
Defining a Circle

Circle is an eight-way symmetric figure. The shape of circle is the same in all quadrants. In each quadrant, there are two octants. If the calculation of the point of one octant is done, then the other seven points can be calculated easily by using the concept of eight-way symmetry.

For drawing, circle considers it at the origin. If a point is $P_1(x, y)$, then the other seven points will



P2 (x, -y)
P3(-x, -y)
P4 (-x, y)
P5 (y, x)
P6 (y, -x)
P7 (-y, -x)
P8 (-y, x)



be

So we will calculate only 45°arc. From which the whole circle can be determined easily.

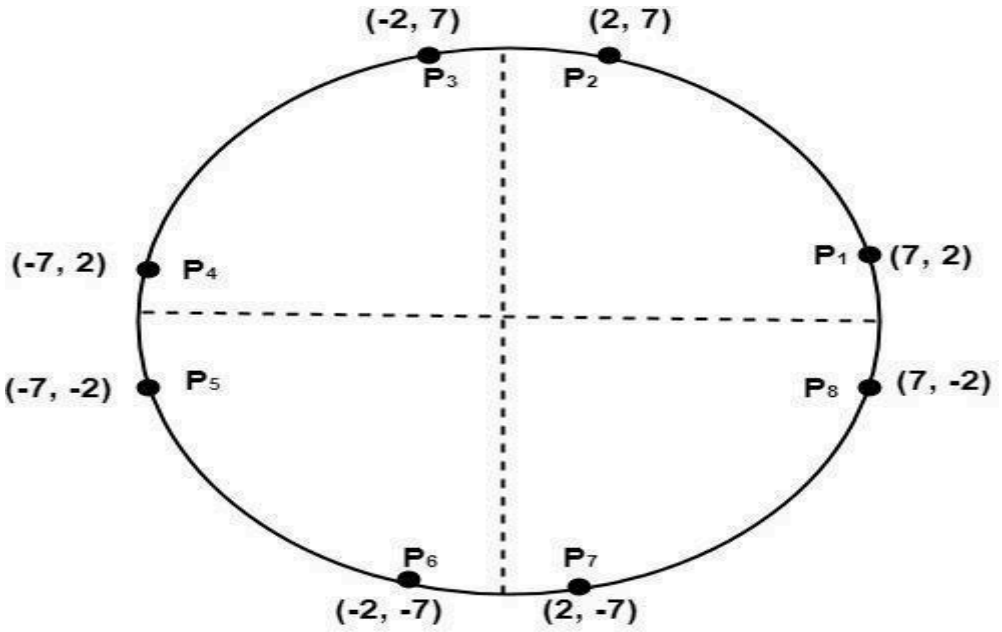
If we want to display circle on screen then the putpixel function is used for eight points as shown below:

putpixel (x, y, color)
putpixel (x, -y, color) putpixel (-x, y, color) putpixel (-x, -y, color) putpixel (y, x, color) putpixel (y, -x, color) putpixel (-y, x, color) putpixel (-y, -x, color)

Example: Let we determine a point (2, 7) of the circle then other points will be (2, -7), (-2, -7), (-2, 7), (7, 2), (-7, 2), (-7, -2), (7, -2)

These seven points are calculated by using the property of reflection. The reflection is accomplished in the following way:

The reflection is accomplished by reversing x, y co-ordinates.

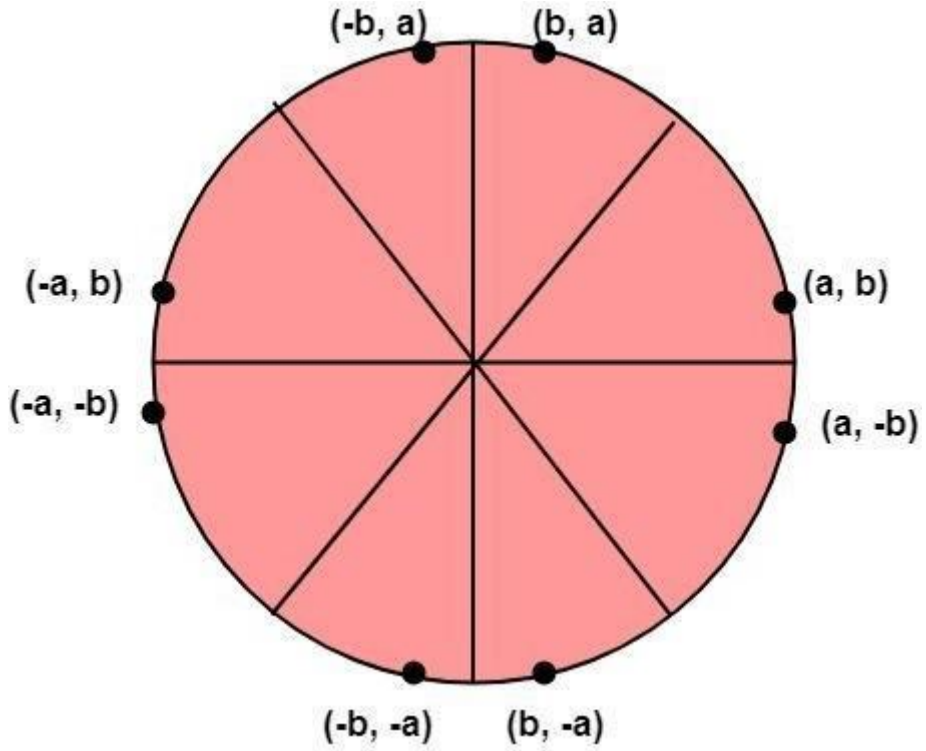


Eight way symmetry of a Circle

MidPoint Circle Algorithm

It is based on the following function for testing the spatial relationship between the arbitrary point (x, y) and a circle of radius r centered at the origin:

$$f(x, y) = x^2 + y^2 - r^2 \quad \begin{bmatrix} < 0 \text{ for } (x,y) \text{inside the circle} \\ = 0 \text{ for } (x,y) \text{on the circle} \\ > 0 \text{ for } (x,y) \text{outside the circle} \end{bmatrix} \text{.....equation 1}$$



Now, consider the coordinates of the point halfway between pixel T and pixel S

This is called midpoint $(x_{i+1}, y_i - \frac{1}{2})$ and we use it to define a decision

parameter: $P_i = f(x_{i+1}, y_i - \frac{1}{2}) = (x_{i+1})^2 + (y_i - \frac{1}{2})^2 - r^2$ equation 2

If P_i is -ve $\Longrightarrow$midpoint is inside the circle and we choose pixel T

If P_i is+ve $\Longrightarrow$midpoint is outside the circle (or on the circle)and we choose

pixel S. The decision parameter for the next step is:

$P_{i+1} = (x_{i+1}+1)^2 + (y_{i+1} - \frac{1}{2})^2 - r^2$ equation 3

Since $x_{i+1} = x_{i+1}$, we have

$$P_{i+1} - P_i = ((x_i + 1) + 1)^2 - (x_i + 1)^2 + (y_{i+1} - \tfrac{1}{2})^2 - (y_i - \tfrac{1}{2})^2$$

$$= x_i^2 + 4 + 4x_i - x_i^2 + 1 - 2x_i + y_{i+1}^2 + \tfrac{1}{4} - y_{i+1} - y_i^2 - \tfrac{1}{4} - y_i$$

$$= 2(xi+1) + 1 + (y_{i+1}^2 - y_i^2) - (y_{i+1} - y_i)$$

$$P_{i+1} = P_i + 2(x_i + 1) + 1 + (y_{i+1}^2 - y_i^2) - (y_{i+1} - y_i) \quad \text{.....equation 4}$$

If pixel T is choosen

$\Longrightarrow P_i < 0$ We have $y_{i+1} = y_i$

If pixel S is choosen

$\Longrightarrow P_i \geq 0$ We have

$y_{i+1} = y_i - 1$

Thus, $$P_{i+1} = \begin{bmatrix} P_i + 2(x_i + 1) + 1, & \text{if } P_i < 0 \\ P_i + 2(x_i + 1) + 1 - 2(y_i - 1), & \text{if } P_i \geq 0 \end{bmatrix} \quad \text{.....equation 5}$$

We can continue to simplify this in n terms of (x_i, y_i) and get

$$P_{i+1} = \begin{bmatrix} P_i + 2x_i + 3, & \text{if } P_i < 0 \\ P_i + 2(x_i - y_i) + 5, & \text{if } P_i \geq 0 \end{bmatrix} \quad \text{.....equation 6}$$

Now, initial value of P_i (0,r)from equation 2

$$P_1 = (0 + 1)^2 + (r - \tfrac{1}{2})^2 - r^2$$

$$= 1 + \tfrac{1}{4} - r^2 = \tfrac{5}{4} - r$$

We can put $\cong$1 5/4 $\therefore$r is an integer So, $P_1 = 1 - r$

Algorithm:

Step 1: Put x=0,y=r in equation2 We have p=1-r
Step 2: Repeat step while x ≤ y Plot (x,y) If (p<0) Then set p=p+2x+3 Else p = p + 2(x-y)+5

y =y-1(end if)x =x+1 (end loop)

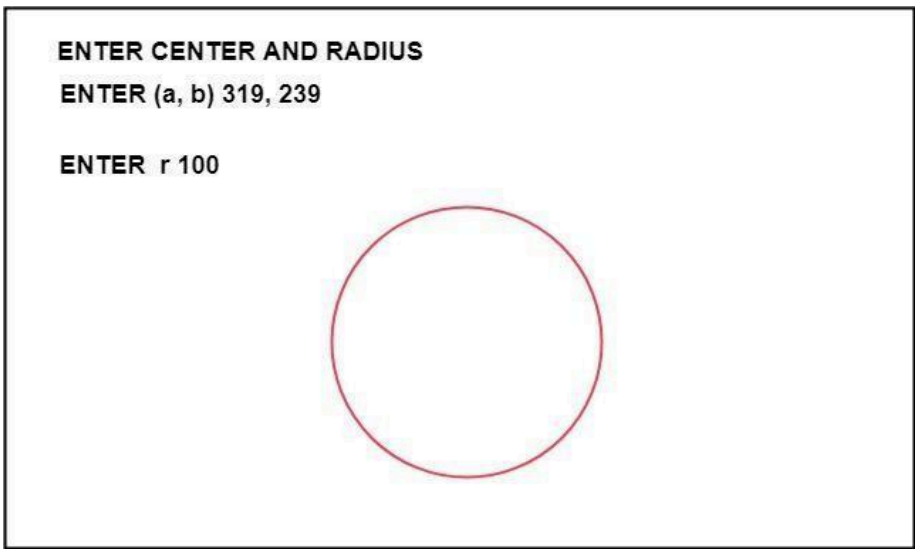
Step3: End

Program to draw a circle using Midpoint Algorithm:

```
1.  #include <graphics.h>
2.  #include <stdlib.h>
3.  #include <math.h>
4.  #include <stdio.h>
5.  #include <conio.h>
6.      #include
<iostream.h>
8. class
bresen 9. {
10.    float x, y,a, b, r, p;
11.    public:
12.    void get ();
13.      void
cal (); 14. };
15.    void main ()
16.    {
17.    bresen b;
18.    b.get ();
19.    b.cal ();
20.    getch ();
21.   }
22.    Void bresen :: get ()
23.   {
24.    cout<<"ENTER CENTER AND RADIUS";
25.     cout<< "ENTER (a, b)";
26.    cin>>a>>b;
27.    cout<<"ENTER r";
28.    cin>>r;
29. }
30. void bresen ::cal ()
31. {
32.    /* request auto detection */
33.    int gdriver = DETECT,gmode, errorcode;
34.    int midx, midy, i;
35.    /* initialize graphics and local variables */
```

```
36.    initgraph (&gdriver, &gmode, " ");
37.    /* read result of initialization */
38.    errorcode = graphresult ();
39.    if (errorcode ! = grOK)    /*an error occurred */
40.    {
41.       printf("Graphics error: %s \n", grapherrormsg (errorcode);
42.       printf ("Press any key to halt:");
43.       getch ();
44.       exit (1); /* terminate with an error code */
45.    }
46.    x=0;
47.    y=r;
48.    putpixel (a, b+r, RED);
49.    putpixel (a, b-r, RED);
50.    putpixel (a-r, b, RED);
51.    putpixel (a+r, b, RED);
52.    p=5/4)-r;
53.    while (x<=y)
54.    {
55.       If (p<0)
56.       p+= (4*x)+6;
57.       else
58.       {
59.          p+=(2*(x-y))+5;
60.          y--;
61.       }
62.       x++;
63.       putpixel (a+x, b+y, RED);
64.       putpixel (a-x, b+y, RED);
65.       putpixel (a+x, b-y, RED);
66.       putpixel (a+x, b-y, RED);
67.       putpixel (a+x, b+y, RED);
68.       putpixel (a+x, b-y, RED);
69.       putpixel (a-x, b+y, RED);
70.       putpixel (a-x, b-y, RED);
71.    }
72. }
```

Output:



Midpoint Ellipse Algorithm:

This is an incremental method for scan converting an ellipse that is centered at the origin in standard position i.e., with the major and minor axis parallel to coordinate system axis. It is very similar to the midpoint circle algorithm. Because of the four-way symmetry property we need to consider the entire elliptical curve in the first quadrant.

Program to draw an ellipse using Midpoint Ellipse Algorithm:

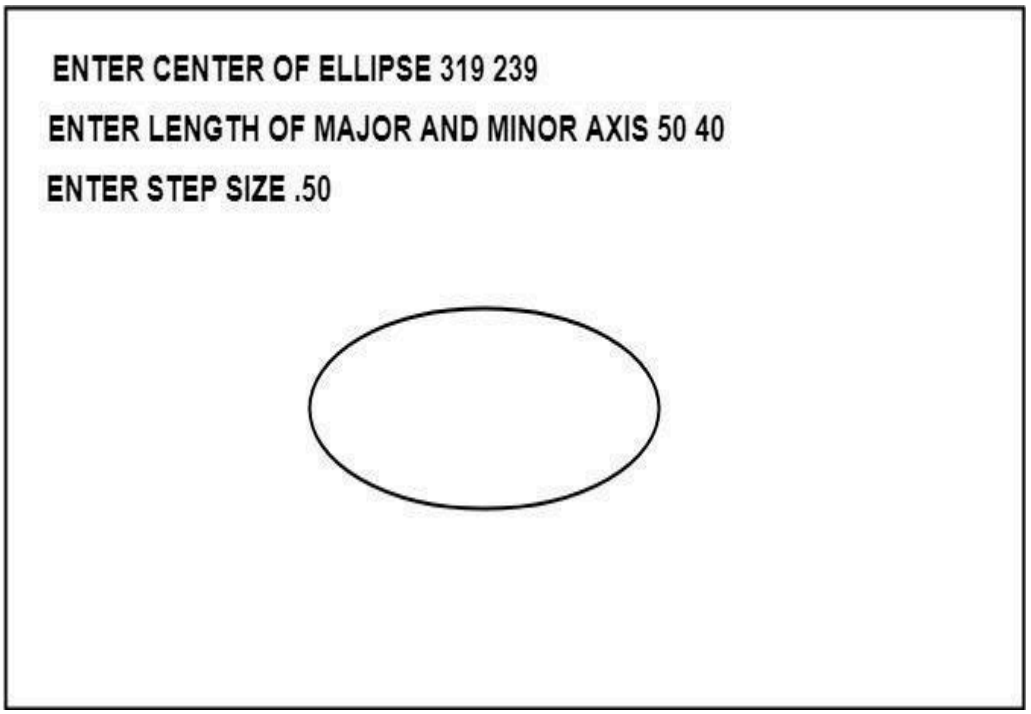
```
1. #include <graphics.h>
2. #include <stdlib.h>
3. #include <math.h>
4. #include <stdio.h>
5. #include <conio.h>
6.       #incl
ude
<iostream.h>
7.
8. class bresen
9. {
10.  float x,y,a, b,r,p,h,k,p1,p2;
11.  public:
12.  void get ();
13.  void cal ();
14. };
15.  void main ()
16.  {
17.  bresen b;
18.  b.get ();
19.  b.cal ();
20.  getch ();
21. }
22.  void bresen :: get ()
23. {
```

```
24.  cout<<"\n ENTER CENTER OF ELLIPSE";
25.  cout<<"\n ENTER (h, k) ";
26.      cin>>h>>k;
27.  cout<<"\n ENTER LENGTH OF MAJOR AND MINOR AXIS";
28.  cin>>a>>b;
29. }
30. void bresen ::cal ()
31. {
32.  /* request auto detection */
33.  int gdriver = DETECT,gmode, errorcode;
34.  int midx, midy, i;
35.  /* initialize graphics and local variables */
36.  initgraph (&gdriver, &gmode, " ");
37.  /* read result of initialization */
38.  errorcode = graphresult ();
39.  if (errorcode ! = grOK) /*an error occurred */
40.  {
41.    printf("Graphics error: %s \n", grapherrormsg (errorcode);
42.    printf ("Press any key to halt:");
43.    getch ();
44.    exit (1); /* terminate with an error code */
45.  }
46.  x=0;
47.  y=b;
48.  // REGION 1
49.  p1 =(b * b)-(a * a * b) + (a * a)/4);
50.  {
```

```
putpixel (x+h, y+k, RED);
putpixel (-x+h, -y+k, RED);
putpixel (x+h, -y+k, RED);
putpixel (-x+h, y+k, RED);
if (p1 < 0)
  p1 += ((2 *b * b) *(x+1))-((2 * a * a)*(y-1)) + (b * b);
else
{
  p1+= ((2 *b * b) *(x+1))-((2 * a * a)*(y-1))-(b * b);
  y--;
}
x++;
}
//REGION 2
p2 =((b * b)* (x + 0.5))+((a * a)*(y-1) * (y-1))-(a * a *b * b);
while (y>=0)
{
  If (p2>0)
  p2=p2-((2 * a * a)* (y-1))+(a
  *a);
  else
  {
  p2=p2-((2 * a * a)* (y-1))+((2 *
  b * b)*(x+1))+(a * a);
  x++;
  }
  y--;
  putpixel (x+h, y+k, RED);
  putpixel (-x+h, -y+k, RED);
  putpixel (x+h, -y+k, RED);
  putpixel (-x+h, y+k, RED);
```

```
80.  }
81.  getch();
82.  }
```

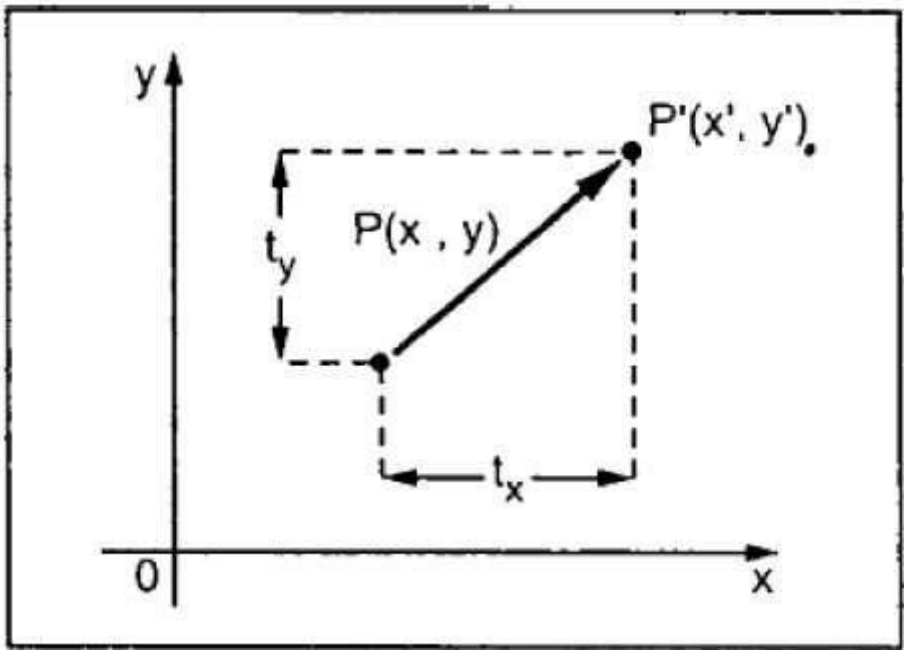
Output:



UNIT 3
TRANSFORMATIONS AND CLIPPING

Transformation means changing some graphics into something else by applying rules. We can have various types of transformations such as translation, scaling up or down, rotation, shearing, etc. When a transformation takes place on a 2D plane, it is called 2D transformation.

Translation
A translation moves an object to a different position on the screen. You can translate a point in 2D by adding translation coordinate (t_x, t_y) to the original coordinate X,Y to get the new coordinate X′,Y.



From the above figure, you can write that −

$$\mathbf{X' = X + t_x}$$

$$\mathbf{Y' = Y + t_y}$$

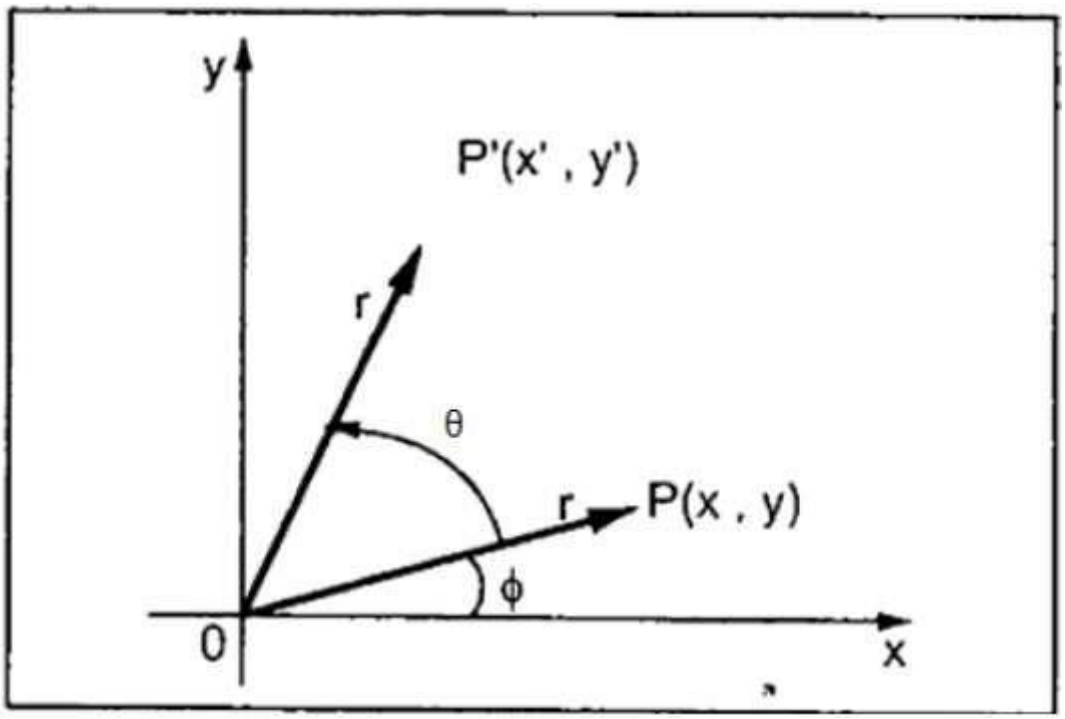
The pair (t_x, t_y) is called the translation vector or shift vector. The above equations can also be represented using the column vectors.

$$P=[X][Y]= p' = [X'][Y']T = [tx][ty]$$

We can write it as −

$$\mathbf{P' = P + T}$$

Rotation
In rotation, we rotate the object at particular angle θ theta ℎ from its origin. From the following figure, we can see that the point PX,Y, is located at angle φ from the horizontal X coordinate with distance r from the origin.
Let us suppose you want to rotate it at the angle θ. After rotating it to a new location, you will get a new point P' X′,Y.



Using standard trigonometric the original coordinate of point PX,Y$\square$,$\square$ can be represented as −

$$X=r\cos\phi \quad \text{.....(1).....(1)}$$

$$Y=r\sin\phi \quad \text{.....(2).....(2)}$$

Same way we can represent the point P' X′, as −

$$x'=r\cos(\phi+\theta)=r\cos\phi\cos\theta-r\sin\phi\sin\theta \quad \text{.....(3)}$$

$$y'=r\sin(\phi+\theta)=r\cos\phi\sin\theta+r\sin\phi\cos\theta \quad \text{.....(4)}$$

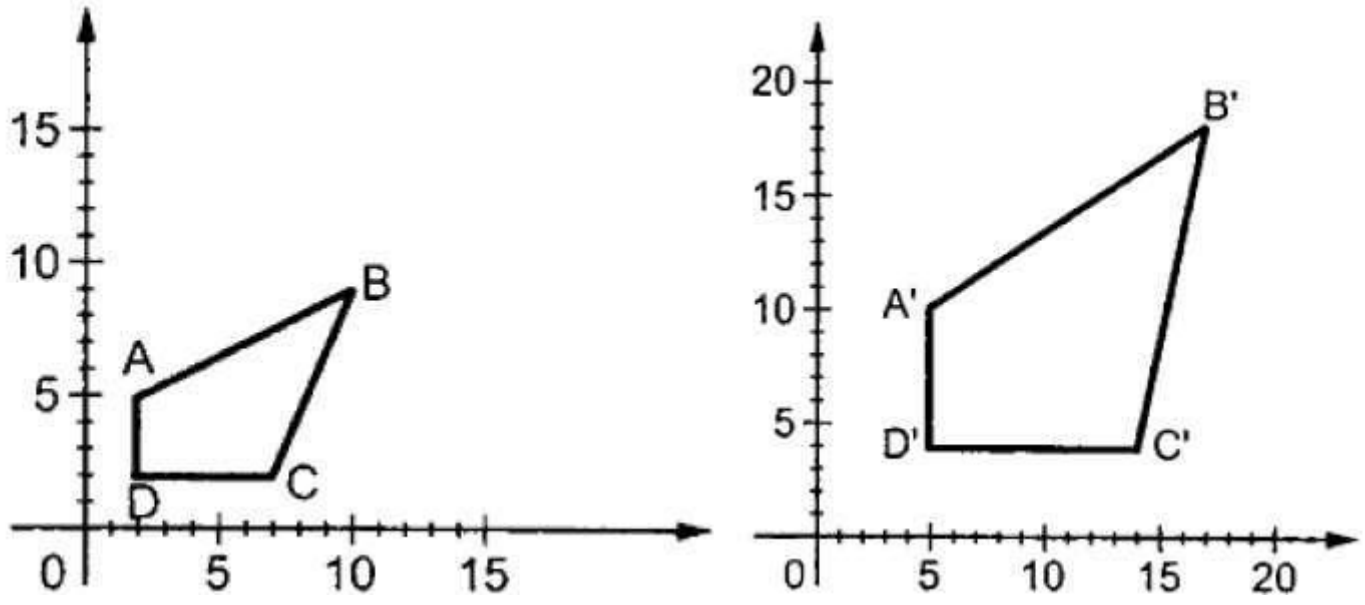
Substituting equation 11 & 22 in 33 & 44 respectively, we will get

$$x'=x\cos\theta-y\sin\theta$$

$$y'=x\sin\theta+y\cos\theta$$

Scaling

To change the size of an object, scaling transformation is used. In the scaling process, you either expand or compress the dimensions of the object. Scaling can be achieved by multiplying the original coordinates of the object with the scaling factor to get the desired result.

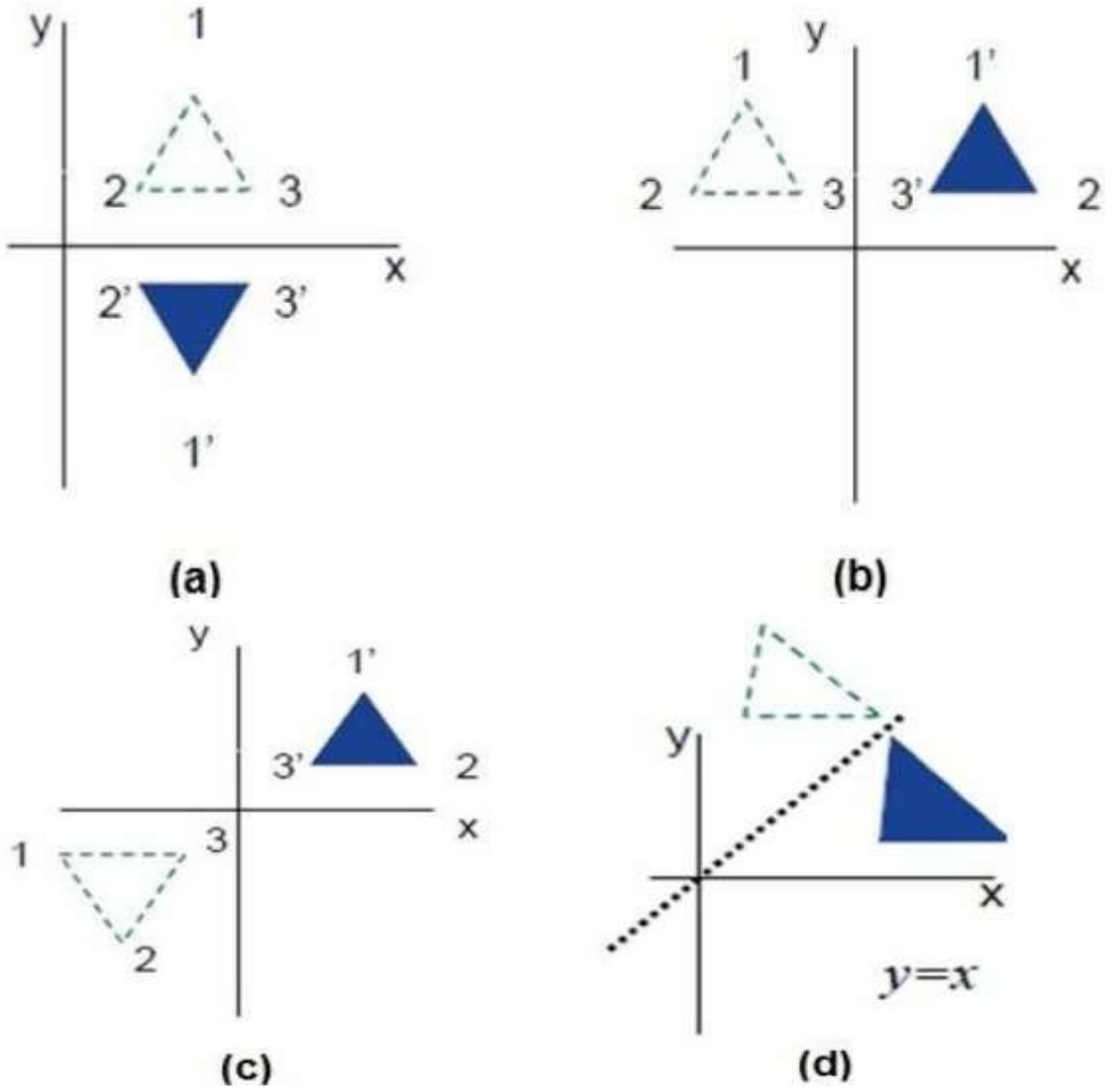


If we provide values less than 1 to the scaling factor S, then we can reduce the size of the object. If we provide values greater than 1, then we can increase the size of the object.

Reflection

Reflection is the mirror image of original object. In other words, we can say that it is a rotation operation with 180°. In reflection transformation, the size of the object does not change.

The following figures show reflections with respect to X and Y axes, and about the origin respectively.



Raster Method for Geometric Transformations

There are many different ways to perform raster transformations, ranging from simple translation and rotation to more complex operations such as scaling, shearing, and reflection. In addition, there are numerous software packages available that can be used to perform raster transformations.

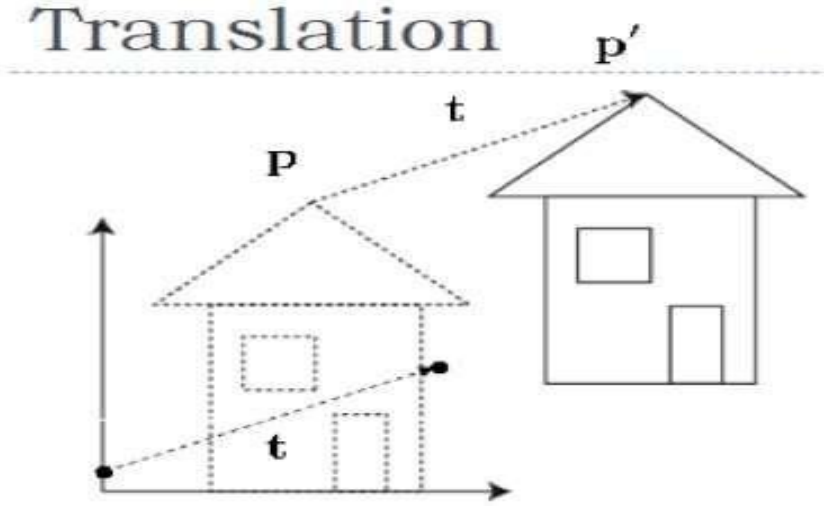
Scaling: There are three main types of scaling: point scaling, line scaling, and area scaling. Point scaling is when the scale factor is applied to individual points. Line scaling is when the scale factor is applied to lines. Area scaling is when the scale factor is applied to areas.

Shearing: Shearing is a raster image transformation that changes the orientation of an image. Shearing can be used to create an illusion of depth or to make an image appear larger or smaller. Shearing can also be used to correct geometric distortions in an image.

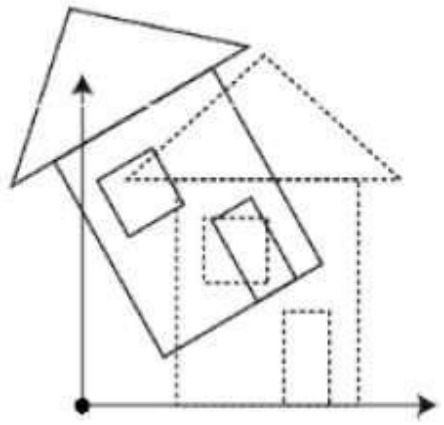
Reflection: There are several ways to mathematically transform raster images. The most common (and computationally simplest) are translation, rotation, and scaling. The translation is the movement of an image along the x- and y-axis. Rotation is the transformation of an image around a certain point, usually the origin (0,0). Scaling is the resizing of an image, which can be done isotropically (maintaining the same aspect ratio) or anisotropically (changing the aspect ratio).

3-D Transformation:
In very general terms a 3D model is a mathematical representation of a physical entity that occupies space. In more practical terms, a 3D model is made of a description of its shape and a description of its color appearance.3-D Transformation is the process of manipulating the view of a three-D object with respect to its original position by modifying its physical attributes through various methods of transformation like Translation, Scaling, Rotation, Shear, etc.

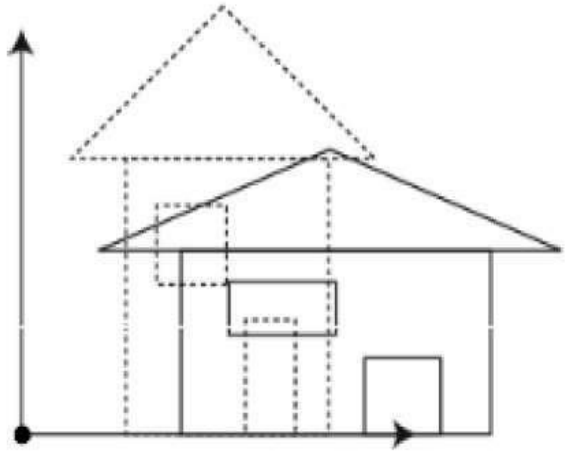
Translation
In 3D translation, we transfer the Z coordinate along with the X and Y coordinates. The process for translation in 3D is similar to 2D translation. A translation moves an object into a different position on the screen.
The following figure shows the effect of translation −



Rotation
3D rotation is not same as 2D rotation. In 3D rotation, we have to specify the angle of rotation along with the axis of rotation. We can perform 3D rotation about X, Y, and Z axes. They are represented in the matrix form as below –

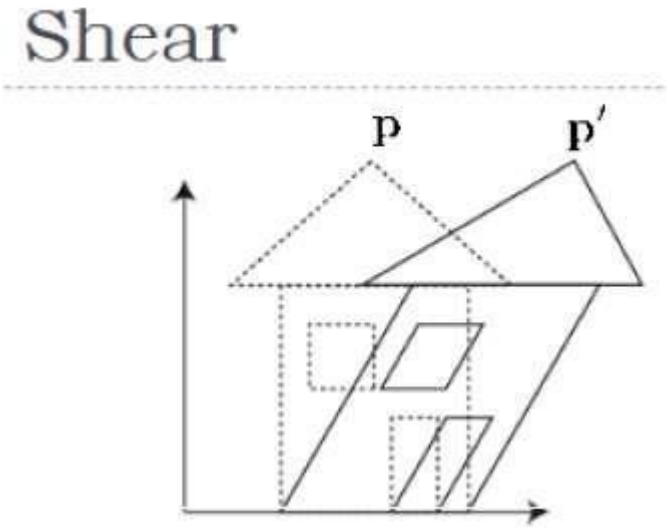


Scaling
You can change the size of an object using scaling transformation. In the scaling process, you either expand or compress the dimensions of the object. Scaling can be achieved by multiplying the original coordinates of the object with the scaling factor to get the desired result. The following figure shows the effect of 3D scaling −



Shear

A transformation that slants the shape of an object is called the shear transformation. Like in 2D shear, we can shear an object along the X-axis, Y-axis, or Z-axis in 3D.



PROJECTIONS

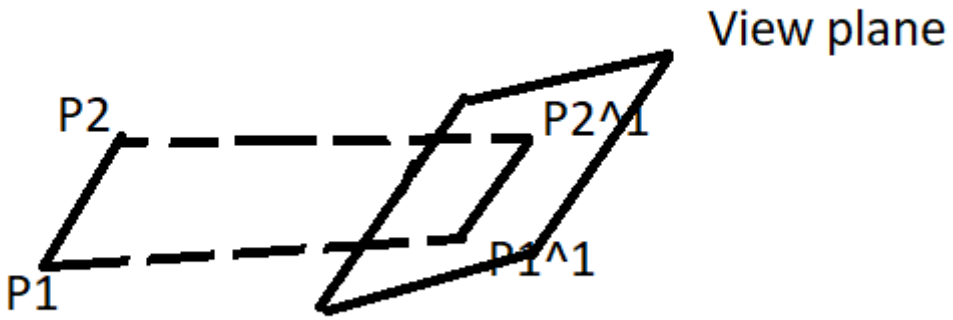
Representing an n-dimensional object into an n-1 dimension is known as projection. It is process of converting a 3D object into 2D object, we represent a 3D object on a 2D plane {(x,y,z)->(x,y)}. It is also defined as mapping or transforming of the object in projection plane or view plane. When geometric objects are formed by the intersection of lines with a plane, the plane is called the projection plane and the lines are called projections.

Types of Projections:

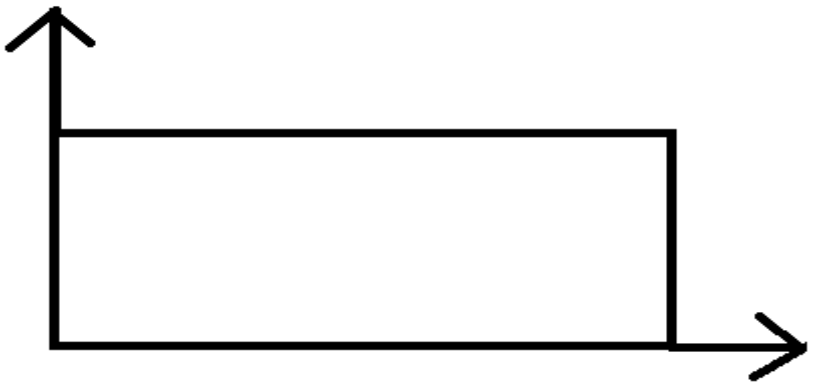
1. Parallel projections
2. Perspective projections

Parallel Projection:

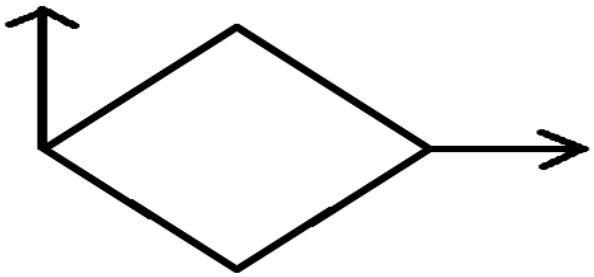
A parallel projection is formed by extending parallel lines from each vertex of object until they intersect plane of screen. Parallel projection transforms object to the view plane along parallel lines. A projection is said to be parallel, if center of projection is at an infinite distance from the projected plane. A parallel projection preserves relative proportion of objects, accurate views of the various sides of an object are obtained with a parallel projection. The projection lines are parallel to each other and extended from the object and intersect the view plane. It preserves relative propositions of objects, and it is used in drafting to produce scale drawings of 3D objects. This is not a realistic representation, the point of intersection is the projection of the vertex.



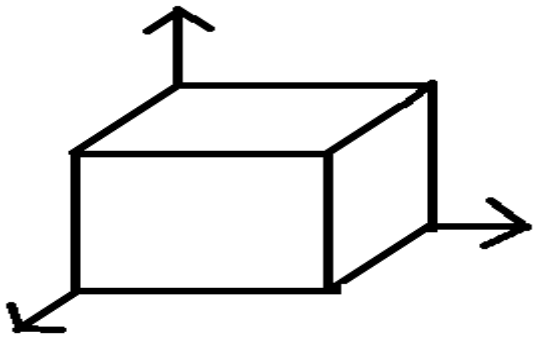
Perspective Projections:
A perspective projection is the one produced by straight lines radiating from a common point and passing through point on the sphere to the plane of projection.
Perspective projection is a geometric technique used to produce a three dimensional graphic image on a plane, corresponding to what person sees.
Any set of parallel lines of object that are not parallel to the projection plane are projected into converging lines. A different set of parallel lines will have a separate vanishing point.
Coordinate positions are transferred to the view plane along lines that converge to a point called projection reference point.
The distance and angles are not preserved and parallel lines do not remain parallel. Instead, they all converge at a single point called center of projection there are 3 types of perspective projections.
Two characteristic of perspective are vanishing point and perspective force shortening. Due to fore shortening objects and lengths appear smaller from the center of projections. The projections are not parallel and we specify a center of projection cop.
Different types of perspective projections:
One point perspective projections: In this, principal axis has a finite vanishing point. Perspective projection is simple to draw.



Two point perspective projections: Exactly 2 principals have vanishing points. Perspective projection gives better impression of depth.



Three point perspective projections: All the three principal axes have finite vanishing point. Perspective projection is most difficult to draw.

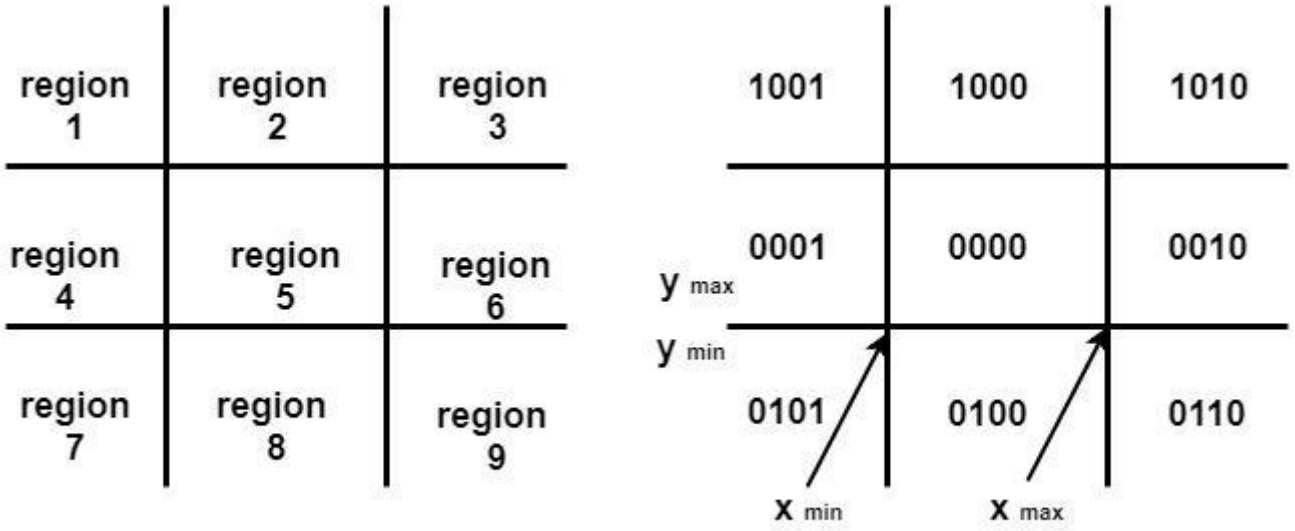


Clipping:
When we have to display a large portion of the picture, then not only scaling & translation is necessary, the visible part of picture is also identified. This process is not easy. Certain parts of the image are inside, while others are partially inside. The lines or elements which are partially visible will be omitted.
For deciding the visible and invisible portion, a particular process called clipping is used. Clipping determines each element into the visible and invisible portion. Visible portion is selected. An invisible portion is discarded.

Cohen Sutherland Line Clipping Algorithm:
In the 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:
Visible
Not Visible
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.
PlayNext
Unmute
Current TimeÂ 0:00
/
DurationÂ 18:10
Loaded: 0.37%
Â
Fullscreen
Backward Skip 10sPlay VideoForward Skip 10s
x_{min},x_{max} are coordinates of the window.
y_{min},y_{max} are also coordinates of the window.

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

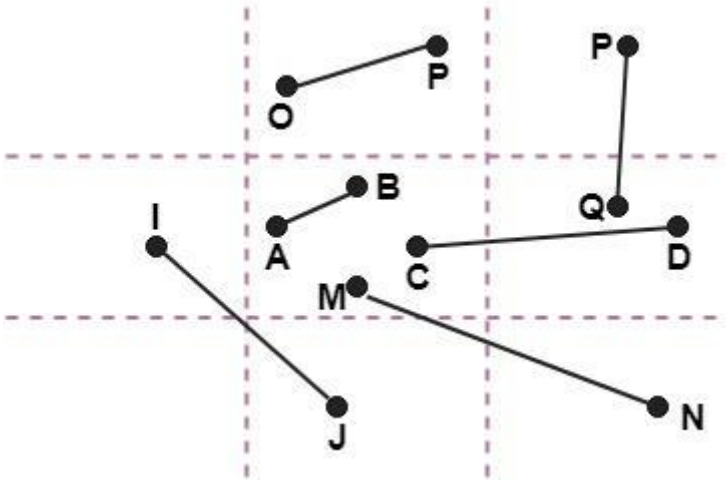
3. Clipping Case: If the line is neither visible case nor invisible case. It is considered to be clipped case. First of all, the category of a line is found based on nine regions given below. All nine regions are assigned codes. Each code is of 4 bits. If both endpoints of the line have end bits zero,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

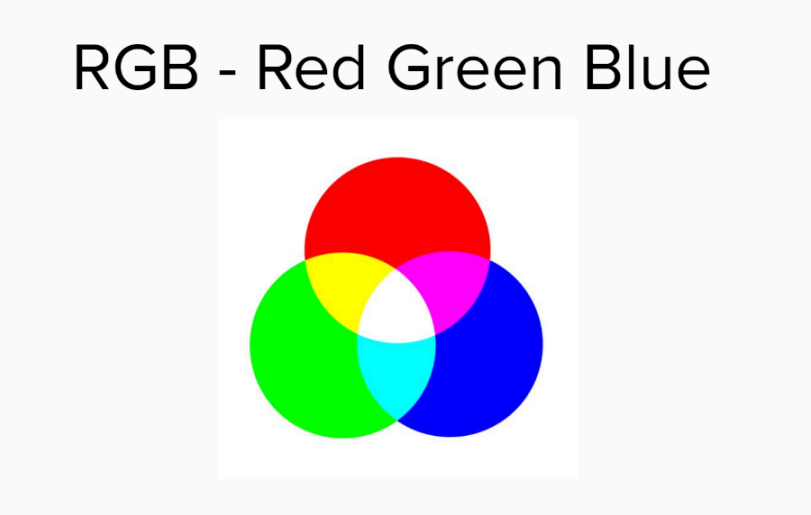


Line AB is the visible case
Line OP is an invisible case
Line PQ is an invisible line
Line IJ are clipping candidates
Line MN are clipping candidate
Line CD are clipping candidate
Advantage of Cohen Sutherland Line Clipping:
It calculates end-points very quickly and rejects and accepts lines quickly.
It can clip pictures much large than screen size.

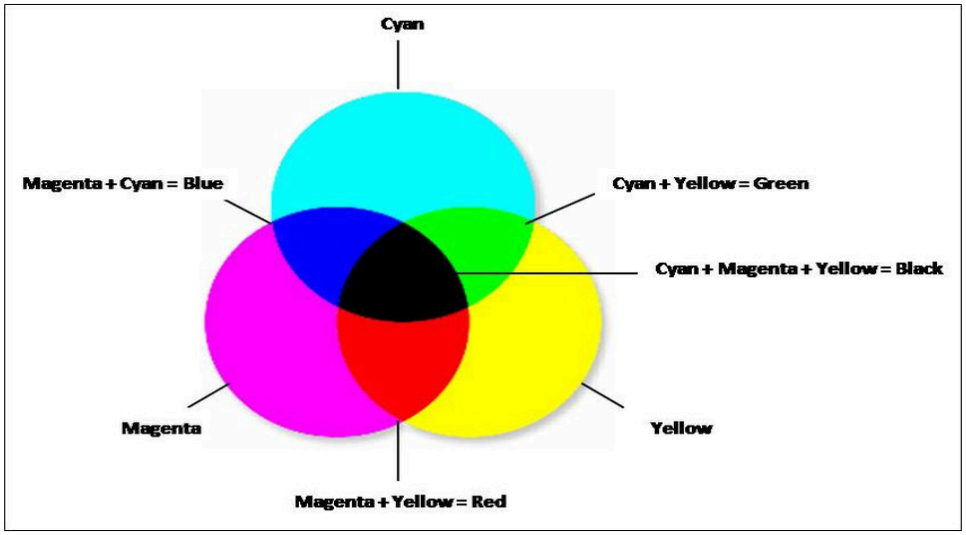
UNIT 4
VIEWING AND COLOR MODELS

Color model:
A color model is a system that helps us to define and describe colors through numerical values. There are many types of color models that use different mathematical systems to represent colors, although most color models typically use a combination of three or four values or color components

RGB: The RGB colour model is the most common colour model used in Digital image processing and openCV. The colour image consists of 3 channels. One channel each for one colour. Red, Green and Blue are the main colour components of this model. All other colours are produced by the proportional ratio of these three colours only. 0 represents the black and as the value increases the colour intensity increases.
Properties:
This is an additive colour model. The colours are added to the black.
3 main channels: Red, Green and Blue.
Used in DIP, openCV and online logos.

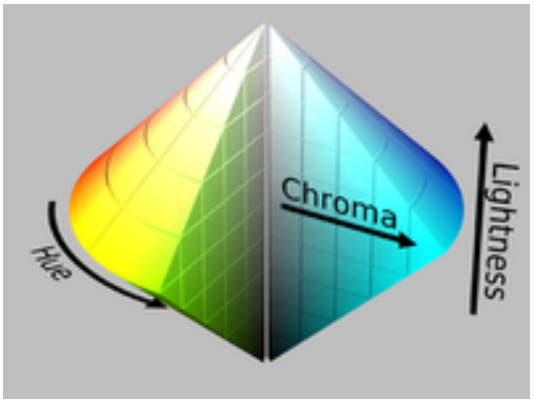


Colour combination:
Green(255) + Red(255) = Yellow
Green(255) + Blue(255) = Cyan
Red(255) + Blue(255) = Magenta
Red(255) + Green(255) + Blue(255) = White
CMYK: CMYK colour model is widely used in printers. It stands for Cyan, Magenta, Yellow and Black (key). It is a subtractive colour model. 0 represents the primary colour and 1 represents the lightest colour. In this model, point (1, 1, 1) represents black, and (0,0,0) represents white. It is a subtractive model thus the value is subtracted from 1 to vary from least intense to a most intense colour value.
1-RGB = CMY
Cyan is negative of Red.
Magenta is negative of Green.
Yellow is negative of Blue.



HSV: The image consists of three channels. Hue, Saturation and Value are three channels. This colour model does not use primary colours directly. It uses colour in the way humans perceive them. HSV colour when is represented by a cone.
Hue is a colour component. Since the cone represents the HSV model, the hue represents different colours in different angle ranges.
Red colour falls between 0 and 60 degrees in the HSV cone.
Yellow colour falls between 61 and 120 degrees in the HSV cone.
Green colour falls between 121 and 180 degrees in the HSV cone.
Cyan colour falls between 181 and 240 degrees in the HSV cone.
Blue colour falls between 241 and 300 degrees in the HSV cone.
Magenta colour falls between 301 and 360 degrees in the HSV cone.
Saturation as the name suggest describes the percentage of the colour. Sometimes this value lies in the 0 to 1 range. 0 being the grey and 1 being the primary colour. Saturation describes the grey colour.
The value represents the intensity of the colour chosen. Its value lies in percentage from 0 to 100. 0 is black and 100 is the brightest and reveals the colour.

HSV model is used in histogram equalization and converting grayscale images to RGB colour images.
YIQ: YIQ is the most widely colour model used in Television broadcasting. Y stands for luminance part and IQ stands for chrominance part. In the black and white television, only the luminance part (Y) was broadcast. The y value is similar to the grayscale part. The colour information is represented by the IQ part.
There exist a formula to convert RGB into YIQ and vice-versa.



YIQ model is used in the conversion of grayscale images to RGB colour images.

UNIT 5
MULTIMEDIA

Multimedia:

Multimedia is a representation of information in an attractive and interactive manner with the use of a combination of text, audio, video, graphics and animation. In other words we can say that Multimedia is a computerized method of presenting information combining textual data, audio, visuals (video), graphics and animations. For examples: E-Mail, Yahoo Messenger, Video Conferencing, and Multimedia Message Service (MMS).

Applications of Multimedia

Following are the common areas of applications of multimedia.

Multimedia in Business- Multimedia can be used in many applications in a business. The multimedia technology along with communication technology has opened the door for information of global wok groups. Today the team members may be working anywhere and can work for various companies. Thus the work place will become global. The multimedia network should support the following facilities:

Voice Mail
Electronic Mail
Multimedia based FAX
Office Needs
Employee Training
Sales and Other types of Group Presentation
Records Management

Multimedia in Marketing and Advertising- By using multimedia marketing of new products can be greatly enhanced. Multimedia boost communication on an affordable cost opened the way for the marketing and advertising personnel. Presentation that have flying banners, video transitions, animations, and sound effects are some of the elements used in composing a multimedia based advertisement to appeal to the consumer in a way never used before and promote the sale of the products.

Multimedia in Entertainment- By using multimedia marketing of new products can be greatly enhanced. Multimedia boost communication on an affordable cost opened the way for the marketing and advertising personnel. Presentation that have flying banners, video transitions, animations, and sound effects are some of the elements used in composing a multimedia based advertisement to appeal to the consumer in a way never used before and promote the sale of the products.

Multimedia in Education- Many computer games with focus on education are now available. Consider an example of an educational game which plays various rhymes for kids. The child can paint the pictures, increase reduce size of various objects etc apart from just playing the rhymes.Several other multimedia packages are available in the market which provide a lot of detailed information and playing capabilities to kids.

Multimedia in Bank- Bank is another public place where multimedia is finding more and more application in recent times. People go to bank to open saving/current accounts, deposit funds, withdraw money, know various financial schemes of the bank, obtain loans etc. Every bank has a lot of information which it wants to impart to in customers. For this purpose, it can use multimedia in many ways. Bank also displays information about its various schemes on a PC monitor placed in the rest area for customers. Today on-line and internet banking have become very popular. These use multimedia extensively. Multimedia is thus helping banks give service to their

customers and also in educating them about banks attractive finance schemes.
Multimedia in Hospital- Multimedia best use in hospitals is for real time monitoring of conditions of patients in critical illness or accident. The conditions are displayed continuously on a computer screen and can alert the doctor/nurse on duty if any changes are observed on the screen. Multimedia makes it possible to consult a surgeon or an expert who can watch an ongoing surgery line on his PC monitor and give online advice at any crucial juncture.
Multimedia Pedagogues- Pedagogues are useful teaching aids only if they stimulate and motivate the students. The audio-visual support to a pedagogue can actually help in doing so. A multimedia tutor can provide multiple numbers of challenges to the student to stimulate his interest in a topic. The instruction provided by pedagogue have moved beyond providing only button level control to intelligent simulations, dynamic creation of links, composition and collaboration and system testing of the user interactions.
Communication Technology and Multimedia Services- The advancement of high computing abilities, communication ways and relevant standards has started the beginning of an era where you will be provided with multimedia facilities at home. These services may include:
Basic Television Services
Interactive entertainment
Digital Audio
Video on demand
Home shopping
Financial Transactions
Interactive multiplayer or single player games
Digital multimedia libraries
E-Newspapers, e-magazines

EVOLVING TECHNOLOGIES FOR MULTIMEDIA SYSTEMS

Multimedia applications use a number of technologies generated for both commercial business application as well as the video game industry.
Let us review some of these technologies in this section.

Hypermedia documents

Hypermedia documents are documents which have text, embedded or linked multimedia objects such as image, audio, hologram, or full-motion video.

Hypertext

Hypertext systems allow authors to link information together, create information paths through a large volume of related text in documents.
It also allows to annotate existing text, and append notes.
It allows fast and easy searching and reading of selected excerpts.

HYPERMEDIA

It is an extension of hypertext.
In that, we can include texts, any kind of information that can be stored in electronic storage, such as audio, animated video, graphics or full-motion video.
Hypermedia documents used for electronic mail and work flow applications provide a rich functionality for exchanging a variety of information types. The hypermedia document is a definition of a document and a set of pointers to help locate the various elements of the document on the network.

HYPER SPEECH

Multimedia stimulated the development of general-purpose speech interfaces. Speech synthesis and speech recognition are fundamental requirement for hyper speech systems. Speech recognition is nothing but converting the analog speech into a computer action and into ASCII text. Speech-recognition systems cannot segment a stream of sounds without breaks into meaningful units. The user must speak in a stilted fashion. He should make sure to interpose silence between each word.

HDTV AND UDTV

HDTV is an acronym of High-Definition Television.
The broadcasting standards such as NTSC, PAL, SECAM, NHK have an idea of bringing the world together on a single high-definition Television broadcasting standard.
The Japanese broadcasting services developed a 1125-line, along MUSE system. A competing standard in the

U.S. changed direction from analog to digital technology: A 1125-line digital HDTV has been developed and is being commercialized. NHK of Japan is trying to leapfrog the digital technology to develop ultra-definition television (digital UDTV) featuring approximately 3000 lines.

MULTIMEDIA INPUT/OUTPUT TECHNOLOGIES

Multimedia Input and Output Devices
Wide ranges of Input and output devices are available for multimedia.

Image Scanners: Image scanners are the scanners by which documents or a manufactured part are scanned. The scanner acts as the camera eye and take a photograph of the document, creating an unaltered electronic pixel representation of the original.

Sound and Voice: When voice or music is captured by a microphone, it generates an electrical signal. This electrical signal has analog sinusoidal waveforms. To digitize, this signal is converted into digital voice using an analog-to-digital converter.

Full-Motion Video: It is the most important and most complex component of Multimedia System. Video Cameras are the primary source of input for full-motion video.

Pen Driver: It is a pen device driver that interacts with the digitizer to receive all digitized information about the pen location and builds pen packets for the recognition context manager. Recognition context manager: It is the main part of the pen system. It is responsible for co-ordinating windows pen applications with the pen. It works with Recognizer, dictionary, and display driver to recognize and display pen drawn objects.

Recognizer: It recognizes hand written characters and converts them to ASCII.

Dictionary: A dictionary is a dynamic link library (DLL); The windows form pen computing system uses this dictionary to validate the recognition results.

Display Driver: It interacts with the graphics device interface' and display hardware. When a user starts writing or drawing, the display driver paints the ink trace on the screen.

COMPRESSION AND DECOMPRESSION

Compression is the way of making files to take up less space. In multimedia systems, in order to manage large multimedia data objects efficiently, these data objects need to be compressed to reduce the file size for storage of these objects.
Compression tries to eliminate redundancies in the pattern of data.
For example, if a black pixel is followed by 20 white pixels, there is no need to store all 20 white pixels. A coding mechanism can be used so that only the count of the white pixels is stored. Once such redundancies are removed, the data object requires less time for transmission over a network. This in turn significantly reduces storage and transmission costs.

TYPES OF COMPRESSION

Compression and decompression techniques are utilized for a number of applications, such as facsimile system, printer systems, document storage and retrieval systems, video teleconferencing systems, and electronic multimedia messaging systems. An important standardization of compression algorithm was achieved by the CCITT when it specified Group 2 compression for facsimile system. .

When information is compressed, the redundancies are removed.

Sometimes removing redundancies is not sufficient to reduce the size of the data object to manageable levels. In such cases, some real information is also removed. The primary criterion is that removal of the real information should not perceptly affect the quality of the result. In the case of video, compression causes some information to be lost; some information at a delete level is considered not essential for a reasonable reproduction of the scene. This type of compression is called lossy compression. Audio compression, on the other hand, is not lossy. It is called lossless compression.

Lossless Compression.
In lossless compression, data is not altered or lost in the process of compression or decompression. Decompression generates an exact replica ofthe original object. Text compression is a good example of lossless compression. The repetitive nature of text, sound and graphic images allows replacement of repeated strings of characters or bits by codes. Lossless compression techniques are good for text data and for repetitive data in images all like binary images and gray-scale images.
Some of the commonly accepted lossless standards are given below:
- v Packpits encoding (Run-length encoding)
- v CCITT Group 3 I D
- v CCITT Group 3 2D
- v CCITT Group 4
- v Lempe l-Ziv and Welch algorithm LZW.

Lossy compression is that some loss would occur while compressing information objects.
Lossy compression is used for compressing audio, gray-scale or color images, and video objects in which absolute data accuracy is not necessary.
The idea behind the lossy compression is that, the human eye fills in the missing information in the case of video.
But, an important consideration is how much information can be lost so that the result should not affect. For example, in a grayscale image, if several bits are missing, the information is still perceived in an acceptable manner as the eye fills in the gaps in the shading gradient.
Lossy compression is applicable in medical screening systems, video tele-conferencing, and multimedia electronic messaging systems.
Lossy compressions techniques can be used alone o~' in combination with other compression methods in a multimedia object consisting of audio, color images, and video as well as other specialized data types.
The following lists some of the lossy compression mechanisms:
- ü Joint Photographic Experts Group (JPEG)
- ü Moving Picture Experts Group (MPEG)
- ü Intel DVI
- ü CCITT H.261 (P * 24) Video Coding Algorithm
- ü Fractals.

DATA AND FILE FORMATS STANDARDS
There are large number of formats and standards available for multimedia system. Let us discuss about the following file formats:
- .:. Rich-Text Format (RTF)
- .:. Tagged Image file Format (TIFF)
- .:. Resource Image File Format (RIFF)
- .:. Musical Instrument Digital Interface (MIDI)
- .:. Joint Photographic Experts Group (JPEG)
- .:. Audio Video Interleaved (AVI) Indeo file format
- .:. TWAIN.

FULL MOTION VIDEO
Most modem cameras use a CCD for capturing the image. HDTV video cameras will be all-digital, and the capture method will be significantly different based on the new NTSC HDTV Standard.
Full-Motion Video Controller Requirements
Video Capture Board Architecture: A full-motion video capture board is a circuit card in the computer that consists of the following components:
(i) Video input to accept video input signals.
(ii) S- Video input to accept RS 170 input.
(iii) Video compression-decompression processor to handle different video compression-decompression algorithms for video data.
(iv) Audio compression-decompression processor to compress and decompress audio data.

(v) Analog to digital converter.
(vi) Digital to analog converter.
(vii)Audio input for stereo audio LINE IN, CD IN. (viii) Microphone.
A video capture board can handle a variety of different audio and video input signals and convert them from analog to digital or digital to analog.
Video Channel Multiplexer: It is similar to the video grabber's video channel multiplexer.
Video Compression and Decompression: A video compression and decompression processor is used to compress and decompress video data.
The video compression and decompression processor contains multiple stages for compression and decompression. The stages include forward discrete cosine transformation and inverse discrete cosine transformation, quantization and inverse quantization, ZigZag and Zero run-length encoding and decoding, and motion estimation and compensation.

Audio Compression: MPEG-2 uses adaptive pulse code modulation (ADPCM) to sample the audio signal. The method takes a difference between the actual sample value and predicted sample value. The difference is then encoded by a 4-bit value or 8-bit value depending upon the sample rate
Analog to Digital Converter: The ADC takes inputs from the video switch and converts the amplitude of a sampled analog signal to either an 8-bit or 16-bit digital value.

STORAGE AND RETRIVAL TECHNOLOGY
Multimedia systems require storage for large capacity objects such as video, audio and images.
Another requirement is delivery of audio and video objects. Storage technologies include battery powered RAM, Nonvolatile flash, rotating magnetic disk drives, and rotating optical disk drives: Let us discuss these technologies in detail.
MAGNETIC MEDIA TECHNOLOGY
Magnetic hard disk drive storage is a mass storage medium.
It has advantages of it continual reduction in the price per mega byte of high-capacity storage. It has high capacity and available in low cost.
In this section let us concentrate on magnetic disk I/O subsystems most applicable to multimedia uses.

HARD DISK TECHNOLOGY
Magnetic hard disk storage remains a much faster mass storage to play an important rol~ in multimedia systems.
It remains a much faster mass storage medium than any other mass storage medium.
ST506 and MFM Hard drives: ST506 is an interface that defines the signals and the operation of signals between a hard disk controller and the hard disk. It is developed by seagate. It is used to control platter speed and the movement of heads for a drive. Parallel data is converted to a series of encoded pulses by using a scheme called MFM (modified frequency modulation). The MFM encoding scheme offers greater packing of bits and accuracy than the FM encoding scheme. Other encoding scheme is Run-Length-Limited. Its drive capacity varies from 20 M Bytes to 200 M Bytes.
ESDI Hard Drive: ESDI (Enhanced Small Device Interface) was developed by a consortium of several manufacturers. It converts the data into serial bit streams.
It uses the Run-Length-Limited Scheme for encoding. The drive has data separator circuitry Drive capacity varies from 80 M Bytes to 2 GB. ESDI interface has two ribbon cables: (i) 36 pin cable for control signals. (ii) 20 pin cable for data signals.
IDE: Integrated Device Electronics (IDE) contains a,n integrated controller with drive.
The interface is 16 bit parallel data interface. The IDE interface supports two IDE drives. One is master drive and other is slave drive. Here, Jumper setting is required. The transfer rate is 8 MHz at bus speed.
New Enhanced IDE Interface
This new interface has a transfer rate of 9-13 M Bytes/See with maximum capacity around 8 GB. It supports upto four drives CD ROM and tape drives.
SCSI (Small Computer System Interface)
It is an ANSI X3T9.2 standard which supports SCSI and SCSI2 Standards. The Standard defines both software and hardware.
SCSI-I:It defines an 8-bit parallel data path between host adapter and device.

Here, host adapter is known as initiator and the device is known as target. There are one initiator and seven targets.

Nine control signals define the activity phases of the SCSI bus during a transaction between an initiator and a target. The phases are:

(i) arbitration phase (ii) selection phase (iii) command phase (iv) data phase (v) status phase (vi) message phase (vii) bus free phase.

Arbitrary Phase: In this phase an initiator starts arbitration and tries to acquire the bus.

Selection Phase: In this phase, an initiator has acquired the bus and selects the target to which it needs to communicate.

Command Phase: The target now enters into this phase. It requests a command from the initiator. Initiator places a command on the bus. It is accepted by the target.

Data Phase: The target now enters in this phase. It requests data transfer with the initiator. The data is placed on the bus by the target and is then accepted by the initiator.

Status Phase: Now, the target enters in status phase. It indicates the end of data transfer to the initiator.

Message Phase: This is the last phase. It is to interrupt the initiator signaling completion of the read message.

The **bus free phase** is a phase without any activity on the bus so that the bus can settle down before the next transaction. SCSI-l transfers data in 8-bit parallel form, and the transfer rate vades rom I M Bytes/See to 5 M Bytes/Sec. SCSI-I'drive capacity varies from 20 M bytes to 2 GB. SCSI-1 has over 64 commands specified to carry out transactions. Commands include read, write, seek, enquiry, copy, verify, copy and verify, compare and so on.