

Graphic input /output devices.

input

Keyboard

mouse

Track ball

Joy Stick

Data glove

Digitizer

Touch panel

Ligit pen.

Voice System

output

Computer

T.V

Graphic Software and Standard

→ General Programming Package

→ Special Purpose application Package

C-fortran Function, Python GL (Graphic library)

CAD, Photoshop CAM - (A SIM)

Software Standard

GKS - Graphical Kernel System

PHIGS - Programmers Hierarchical Inductive Graphic System

PHIGS +

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DDA Algorithm.

line equation $y = mx + c$

(i) input 2 points A(x₁, y₁) B(x₂, y₂)

(ii) $\Delta x = x_2 - x_1$, $\Delta y = y_2 - y_1$

$$S = \Delta x$$

(iii) if $(\text{abs}(\Delta x) > \text{abs}(\Delta y))$

$$S = \text{abs}(\Delta x)$$

else.

(iv) $S = \text{abs}(\Delta y)$

$$x_i = \Delta x/S, y_j = \Delta y/S$$

(v) Plot points $x_{k+1} = x_k + x_i$

$$y_{k+1} = y_k + y_i$$

$$(10, 20) \rightarrow (30, 28)$$

$$\Delta x = 20, S = 20$$

$$\Delta y = 8$$

Bresenham Line Drawing Algo:-

1) i/P A(x₁, y₁) B(x₂, y₂)

2) $\Delta x = x_2 - x_1$, $\Delta y = y_2 - y_1$

3) calculate initial decision parameter

$$P_0 = 2 \Delta y - (\Delta x + 1)$$

if ($P_k < 0$)

$$P_{k+1} = P_k + 2 \Delta y$$

$$x_{k+1} = x_k + 1, y_{k+1} = y_k$$

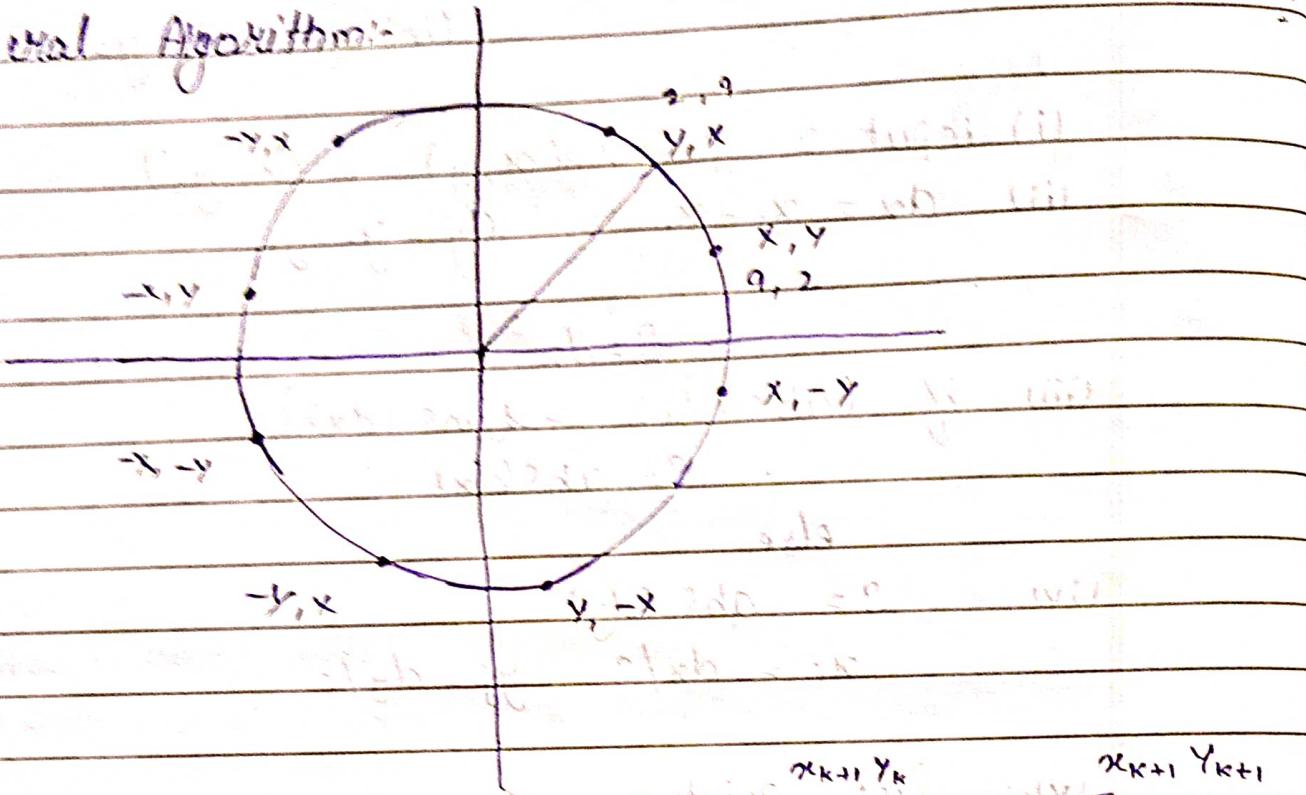
$$\rightarrow P_{k+1} = P_k + 2 \Delta y - 2 \Delta x$$

$$P_{k+1} = x_{k+1}, y_{k+1} = y_k + 1$$

else \rightarrow

Mid-Point circle

General Algorithm



Mid-Point Algo:

- 1) i/P center (x_c, y_c) and radius r .
- 2) Calculate initial decimal perimeter.

Step:

$$P_0 = \frac{5}{4}r^2 - r$$

$$\text{or } P_0 = 1 - r$$

3) if $(P_k < 0)$

$$(x_{k+1}, y_k)$$

else

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

if:

$$P_{k+1} = P_k - x_{k+1} + 1, -2y_{k+1}$$

4) Determine symmetry points

5) calculate actual x, y by using centre co-ordinates.

6) Repeat (3) to (5) until $x \geq y$

$$x = x + y$$

$$y = y + y_c$$

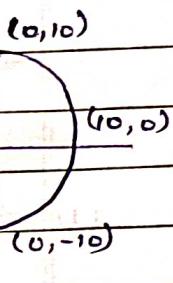
Ques.

find all the points of a circle when the radius is $\underline{r=10}$.

$$P_0 = 1 - r$$

$$P_0 = 1 - 10$$

$$P_0 = -9$$



P_k

P_{k+1}

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

calculation.

-9

-6

(0, 10)

$$P_{k+1} = -9 + 2 \times 1 + 1 \\ = -9 + 2 + 1 = -6$$

-6

-1

(1, 10)

$$P_{k+1} = -9 + 2 \times 1 + 1 \\ = -9 + 2 + 1 = -6$$

-1

6

(2, 10)

$$P_{k+1} = -1$$

6

-3

(3, 10)

$$P_{k+1} = 6$$

-3

8

(4, 9)

$$P_{k+1} = -3$$

8

5

(5, 9)

$$P_{k+1} = 8$$

5

8

(6, 8)

$$P_{k+1} = 5$$

8

5

(7, 7)

$$P_{k+1} = 5$$

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Bresenham Circle drawing Algorithm.

- (1) Set initial values centre (x_c, y_c) and radius r .
- (2) Calculate initial decimal parameter $d = 3 - (2r)$
- (3) Display / Plot points $(0, r)$
- (4) Run Step 5 to 8 until $x <= y$
- (5) Increment value of x
- (6) if $d < 0$ set $d = d + 4x + 6$
- (7) else ($d > 0$) set $d = d + 4(x-y) + 10$. Decrement 'y' by '1'.
- (8) Plot new Point (x, y)
- (9) Exit

Example: $\Rightarrow (x_c, y_c) = (0, 0), r = 8$

$$d = 3 - (2r)$$

$$d = 3 - (16)$$

$$d = -13$$

P_k	P_{k+1}	(x_{k+1}, y_{k+1})	calculation
-13	-3	(0, 8)	$d = -13 + 4 \cdot 1 + 6$
-3	11	(1, 8)	$d = -3$
-3	11	(2, 8)	$d = -3 + 8 + 6$
11	5	(3, 7)	$d = 11$
5	7	(4, 6)	$d = 11 + 4(3-8) + 10$
7	5	(5, 5)	$d = 5 + 4(2-8) + 10$

PTO

$\begin{array}{c} + \\ - \\ \hline + \\ - \end{array}$

Magic

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Maths

Ex 10.3

Plot:

(x, y) ($-x, y$) ($-x, -y$) ($x, -y$)

(0, 8)

(1, 8)

(2, 8)

(3, 7)

(4, 6)

(5, 5)

(6, 4)

(7, 3)

(8, 2)

(8, 1)

(8, 0)

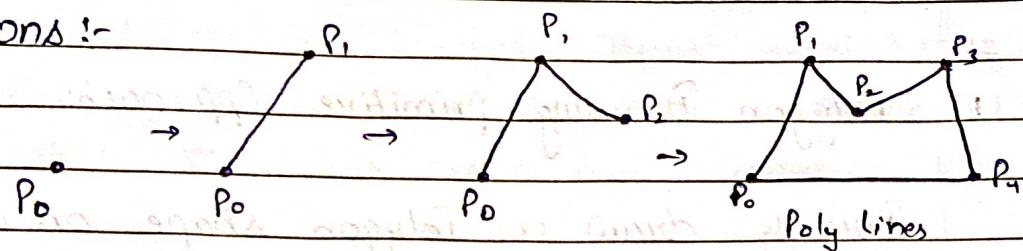
(x, y) along left. going

$a+b = b$ \Rightarrow $a = 0$

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Polygons :-



Types of Polygons:-

(a) Convex :-

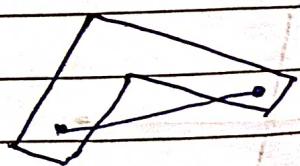
If we draw a line segment inside a polygon which joining any two point within a polygon.

All angles of polygon are less than 180° .

If a line adjoining any two points which are inside a polygon is completely inside it.



(b) Concave :- If a line adjoining any two points within a polygon are partially or completely outside a polygon is a concave polygon.



At least one angle of polygon is greater than 180°

Representation:-

(1) Polygon Drawing primitive Approach:-

Directly draw a polygon shape on a device and that polygon saved as a one unit.

(2) Trapezoid Primitive approach:-

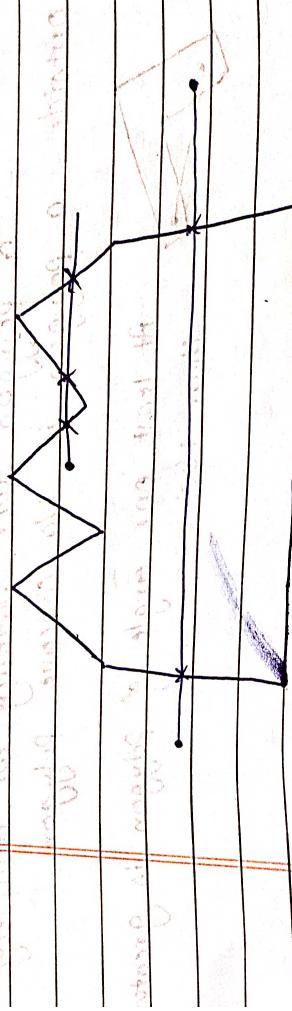
A graphic system in which trapezoids are used as a basic shape for drawing polygon.

3. Line And Point approach:-

Where the polygon drawing approach not supported by the graphic system then the polygon are made by the Standard approach

Line and point drawing said as Inside / Outside Test - A according to which

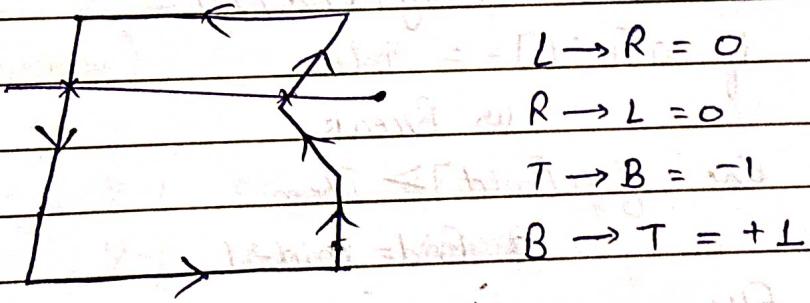
iii) Odd-Even method :- (odd parity method):-



if odd intersection then point is inside
if even intersection then point is outside.

- if intersection point is vertex and both lines are on one (same) side then point will be counted 2
- if intersection point is vertex and lines are not on same side then point will be counted 1

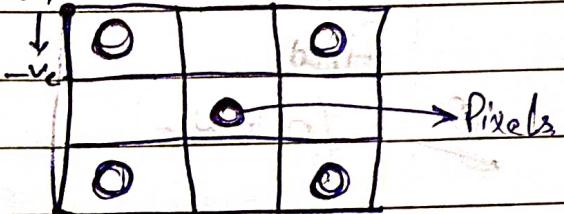
Winding No. Method



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Area filling Algorithm:-

 $(0,0) \rightarrow \text{true}$ fill ($x, y, \text{color}, \text{colour}-I$)

{ int c;

fill pixel ($x, y, \text{colour}, \text{colour}-I$)

{ if ((c < colour) & (c > colour-I))

fill ($x+1, y-1, \text{colour}, \text{colour}-I$)fill ($x+1, y-1, \text{colour}, \text{colour}-I$)fill ($x-1, y+1, \text{colour}, \text{colour}-I$)fill ($x+1, y+1, \text{colour}, \text{colour}-I$)

}

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Polygon filling Algo.

Seed filling Algo

Boundary filling Algo.

4 connected

8 connected

Flood filling Algo

4 connected

8 connected

Scanline Polygon Filling Algo

flood fill ($x, y, \text{old_c}, \text{new_c}$)< if (get pixel colour (x, y) == old_c)< put pixel ($x, y, \text{new_c}$)flood fill ($x-1, y-1, \text{old_c}, \text{new_c}$)flood fill ($x+1, y-1, \text{old_c}, \text{new_c}$)flood fill ($x-1, y+1, \text{old_c}, \text{new_c}$)flood fill ($-x+1, y-1, \text{old_c}, \text{new_c}$)

Scan line Algo:-

Steps

- (1) Locate the intersection point of the scan line with Polygon edge.
- (2) Pairing Intersection Points
- (3) Move down, side as per scan line and sort all pairs
- (4) All pairs are sorted from Y_{max} to Y_{min} or vice versa
- (5) Sides get sorted as per intersection points.
- (6) Area filling starts now.

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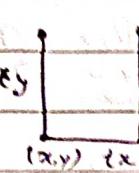
Unit 8

2-D Transformation:-

Basic Transformations

- Translation
- Rotation
- Scaling
- [Reflection
Shear]

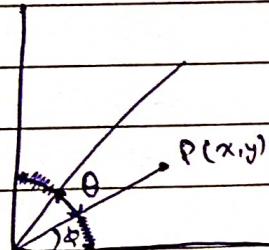
Translation



$$x' = x + tx$$
$$y' = y + ty$$

$$P' = P + T$$

Rotation:-



$$x = r \cos \phi \quad \text{--- (1)}$$

$$y = r \sin \phi \quad \text{--- (2)}$$

$$x' = r \cos(\phi + \theta) = \cos \alpha \cos \theta - \sin \alpha \sin \theta$$

$$y' = r \sin(\phi + \theta) = \sin \alpha \cos \theta + \cos \alpha \sin \theta$$

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

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

$$= x \cos \theta - \cancel{r} \sin \theta$$

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

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} \begin{bmatrix} \cos \theta & \sin \theta \\ \sin \theta & -\cos \theta \end{bmatrix} \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}$$

Rotation matrix

$$P' = PR$$

UNIT- I Basic of Computer Graphics

What is computer Graphics?

Computer graphics is an art of drawing pictures, lines, charts, etc. using computers with the help of programming. Computer graphics image is made up of number of pixels. **Pixel** is the smallest addressable graphical unit represented on the computer screen.

Introduction

- Computer is information processing machine. User needs to communicate with computer and the computer graphics is one of the most effective and commonly used ways of communication with the user.
- It displays the information in the form of graphical objects such as pictures, charts, diagram and graphs.
- Graphical objects convey more information in less time and easily understandable formats for example statically graph shown in stock exchange.
- In computer graphics picture or graphics objects are presented as a collection of discrete pixels.
- We can control intensity and color of pixel which decide how picture look like.
- The special procedure determines which pixel will provide the best approximation to the desired picture or graphics object this process is known as **Rasterization**.
- The process of representing continuous picture or graphics object as a collection of discrete pixels is called **Scan Conversion**.

Objectives:

- To provide comprehensive introduction about computer graphics system, design algorithms and two dimensional transformations.
- To make the students familiar with techniques of clipping, three dimensional graphics and three dimensional transformations.
- The computer graphics course prepares students for activities involving in design, development and testing of modelling, rendering, shading and animation.
- To list the basic components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
- To learn the basic principles of 3- dimensional computer graphics.
- Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
- Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
- To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Outcomes:

Students will be able to:

- To list the basic concepts used in computer graphics.
- To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
- To describe the importance of viewing and projections.
- To define the fundamentals of animation, virtual reality and its related technologies.

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- To understand a typical graphics pipeline
- To design an application with the principles of virtual reality

Scope

1. Paint programs – Allows to draw free hand graphics.
2. Illustration / design programs – Supports advanced features than simple paint programs, specifically drawing curved lines.
3. Presentation Graphics – Allows to create bar charts, pie charts and other images to create slides.
4. Animation Software – Allows to chain sequence of series of images to simulate movements.
5. CAD software - Allows architects, engineers to produce designs.

Advantages of computer graphics

- Computer graphics is one of the most effective and commonly used ways of communication with computer.
- It provides tools for producing picture of “real-world” as well as synthetic objects such as mathematical surfaces in 4D and of data that have no inherent geometry such as survey result.
- It has ability to show moving pictures thus possible to produce animations with computer graphics.
- With the use of computer graphics we can control the animation by adjusting the speed, portion of picture in view the amount of detail shown and so on.
- It provides tools called motion dynamics. In which user can move objects as well as observes as per requirement for example walk throw made by builder to show flat interior and surrounding.
- It provides facility called update dynamics. With this we can change the shape color and other properties of object.
- Now in recent development of digital signal processing and audio synthesis chip the interactive graphics can now provide audio feedback along with the graphical feed backs.

Application of computer graphics

- User interface: - Visual object which we observe on screen which communicates with user is one of the most useful applications of the computer graphics.
- Plotting of graphics and chart in industry, business, government and educational organizations drawing like bars, pie-charts, histogram's are very useful for quick and good decision making.
- Office automation and desktop publishing: - It is used for creation and dissemination of information. It is used in in-house creation and printing of documents which contains text, tables, graphs and other forms
- Computer aided drafting and design: - It uses graphics to design components and system such as automobile bodies structures of building etc.

- Simulation and animation: - Use of graphics in simulation makes mathematic models and mechanical systems more realistic and easy to study.
- Art and commerce: - There are many tools provided by graphics which allows used to make their picture animated and attracted which are used in advertising.
- Process control: - Now a day's automation is used which is graphically displayed on the screen.
- Cartography: - Computer graphics is also used to represent geographic maps, weather maps, oceanographic charts etc.
- Education and training: - Computer graphics can be used to generate models of physical, financial and economic systems. These models can be used as educational aids.
- Image processing: - It is used to process image by changing property of the image.

Display devices

- Display devices are also known as output devices.
- Most commonly used output device in a graphics system is a video monitor.

Cathode-ray-tubes

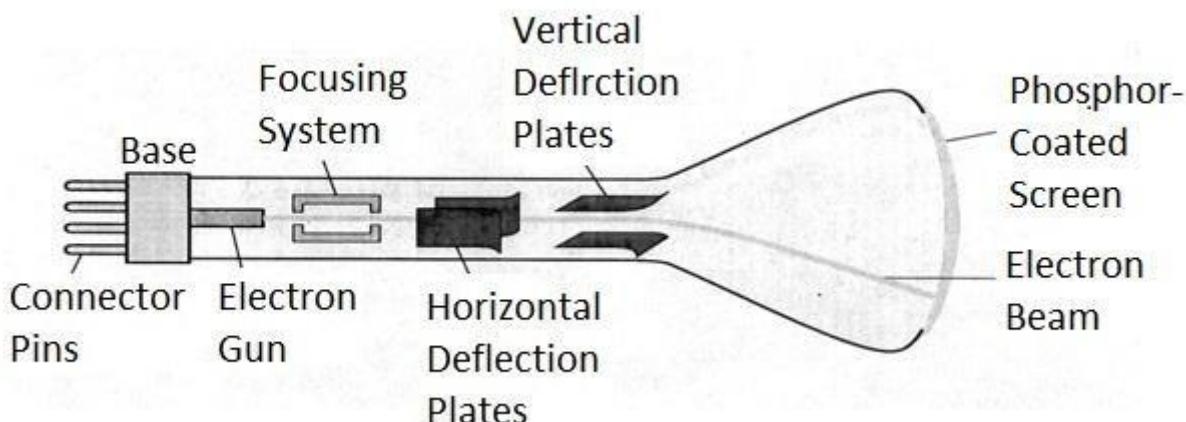


Fig. 1.1: - Cathode ray tube.

- It is an evacuated glass tube.
- An electron gun at the rear of the tube produce a beam of electrons which is directed towards the screen of the tube by a high voltage typically 15000 to 20000 volts
- Inner side screen is coated with phosphor substance which gives light when it is stroked by electrons.
- Control grid controls velocity of electrons before they hit the phosphor.
- The control grid voltage determines how many electrons are actually in the electron beam. The negative the control voltage is the fewer the electrons that pass through the grid.
- Thus control grid controls Intensity of the spot where beam strikes the screen.
- The focusing system concentrates the electron beam so it converges to small point when hits the phosphor coating.
- Deflection system directs beam which decides the point where beam strikes the screen.
- Deflection system of the CRT consists of two pairs of parallel plates which are vertical and horizontal deflection plates.
- Voltage applied to vertical and horizontal deflection plates is control vertical and horizontal deflection respectively.
- There are two techniques used for producing images on the CRT screen:

1. Vector scan/Random scan display.
2. Raster scan display.

Vector scan/Random scan display

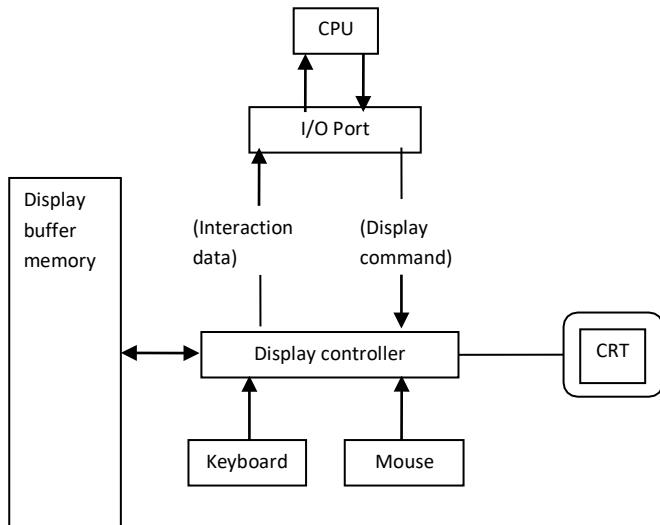


Fig. 1.2: - Architecture of a vector display.

- Vector scan display directly traces out only the desired lines on CRT.
- If we want line between point p1 & p2 then we directly drive the beam deflection circuitry which focus beam directly from point p1 to p2.
- If we do not want to display line from p1 to p2 and just move then we can blank the beam as we move it.
- To move the beam across the CRT, the information about both magnitude and direction is required. This information is generated with the help of vector graphics generator.
- Fig. 1.2 shows architecture of vector display. It consists of display controller, CPU, display buffer memory and CRT.
- Display controller is connected as an I/O peripheral to the CPU.
- Display buffer stores computer produced display list or display program.
- The Program contains point & line plotting commands with end point co-ordinates as well as character plotting commands.
- Display controller interprets command and sends digital and point co-ordinates to a vector generator.
- Vector generator then converts the digital co-ordinate value to analog voltages for beam deflection circuits that displace an electron beam which points on the CRT's screen.
- In this technique beam is deflected from end point to end point hence this techniques is also called random scan.
- We know as beam strikes phosphors coated screen it emits light but that light decays after few milliseconds and therefore it is necessary to repeat through the display list to refresh the screen at least 30 times per second to avoid flicker.
- As display buffer is used to store display list and used to refreshing, it is also called refresh buffer.

Raster scan display

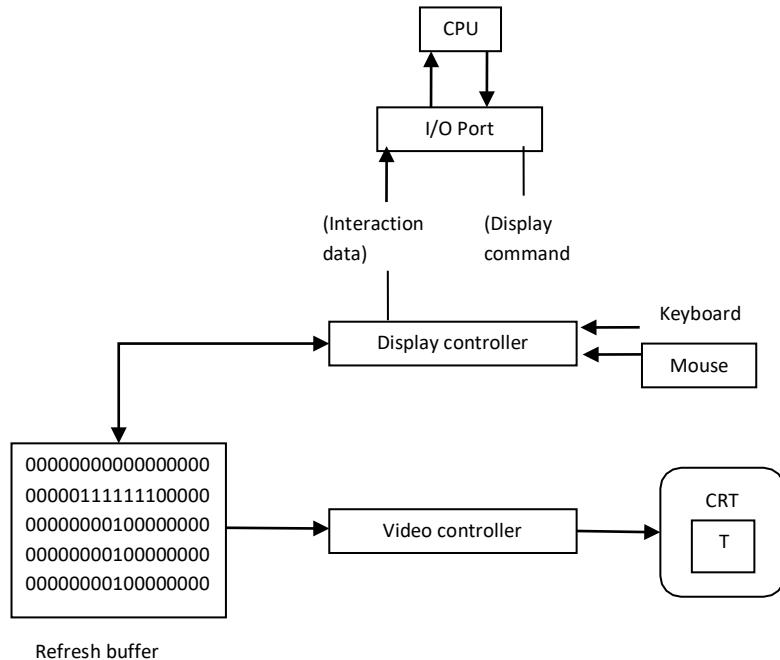


Fig. 1.3: - Architecture of a raster display.

- Fig. 1.3 shows the architecture of Raster display. It consists of display controller, CPU, video controller, refresh buffer, keyboard, mouse and CRT.
- The display image is stored in the form of 1's and 0's in the refresh buffer.
- The video controller reads this refresh buffer and produces the actual image on screen.
- It will scan one line at a time from top to bottom & then back to the top.

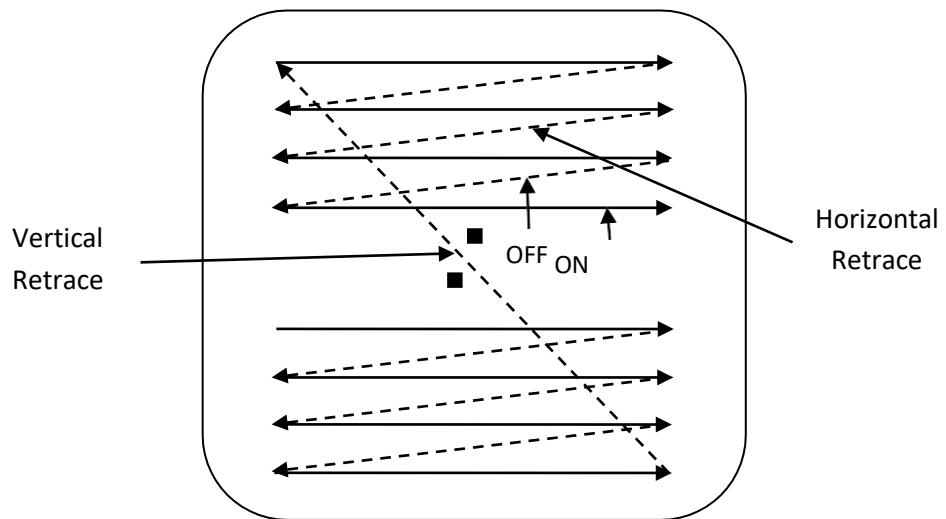


Fig. 1.4: - Raster scan CRT.

- In this method the horizontal and vertical deflection signals are generated to move the beam all over the screen in a pattern shown in fig. 1.4.
- Here beam is swept back & forth from left to the right.
- When beam is moved from left to right it is ON.

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- When beam is moved from right to left it is OFF and process of moving beam from right to left after completion of row is known as **Horizontal Retrace**.
- When beam is reach at the bottom of the screen. It is made OFF and rapidly retraced back to the top left to start again and process of moving back to top is known as **Vertical Retrace**.
- The screen image is maintained by repeatedly scanning the same image. This process is known as **Refreshing of Screen**.
- In raster scan displays a special area of memory is dedicated to graphics only. This memory is called **Frame Buffer**.
- Frame buffer holds set of intensity values for all the screen points.
- That intensity is retrieved from frame buffer and display on screen one row at a time.
- Each screen point referred as pixel or **Pel (Picture Element)**.
- Each pixel can be specified by its row and column numbers.
- It can be simply black and white system or color system.
- In simple black and white system each pixel is either ON or OFF, so only one bit per pixel is needed.
- Additional bits are required when color and intensity variations can be displayed up to 24-bits per pixel are included in high quality display systems.
- On a black and white system with one bit per pixel the frame buffer is commonly called a **Bitmap**. And for systems with multiple bits per pixel, the frame buffer is often referred as a **Pixmap**.

Difference between random scan and raster scan

Base of Difference	Raster Scan System	Random Scan System
Electron Beam	The electron beam is swept across the screen, one row at a time, from top to bottom.	The electron beam is directed only to the parts of screen where a picture is to be drawn.
Resolution	Its resolution is poor because raster system in contrast produces zigzag lines that are plotted as discrete point sets.	Its resolution is good because this system produces smooth lines drawings because CRT beam directly follows the line path.
Picture Definition	Picture definition is stored as a set of intensity values for all screen points, called pixels in a refresh buffer area.	Picture definition is stored as a set of line drawing instructions in a display file.
Realistic Display	The capability of this system to store intensity values for pixel makes it well suited for the realistic display of scenes contain shadow and color pattern.	These systems are designed for line-drawing and can't display realistic shaded scenes.
Draw an Image	Screen points/pixels are used to draw an image.	Mathematical functions are used to draw an image.

Color CRT monitors

- A CRT monitor displays color pictures by using a combination of phosphors that emit different colored light.
- It produces range of colors by combining the light emitted by different phosphors.
- There are two basic techniques for color display:
 1. Beam-penetration technique
 2. Shadow-mask technique

Beam-penetration technique

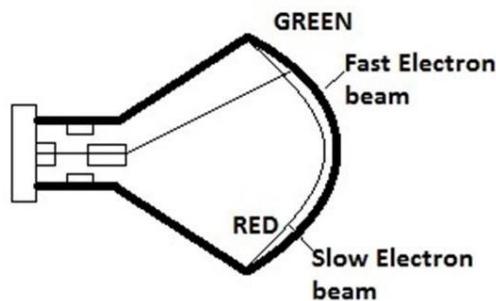


Fig. 1.5: - Beam-penetration CRT

- This technique is used with random scan monitors.
- In this technique inside of CRT coated with two phosphor layers usually red and green. The outer layer of red and inner layer of green phosphor.
- The color depends on how far the electron beam penetrates into the phosphor layer.
- A beam of fast electron penetrates more and excites inner green layer while slow electron excites outer red layer.
- At intermediate beam speed we can produce combination of red and green lights which emit additional two colors orange and yellow.
- The beam acceleration voltage controls the speed of the electrons and hence color of pixel.
- It is a low cost technique to produce color in random scan monitors.
- It can display only four colors.
- Quality of picture is not good compared to other techniques.

Shadow-mask technique

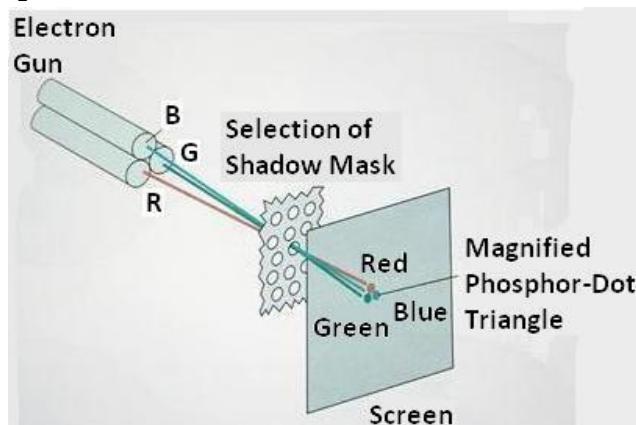


Fig. 1.6: - Shadow-mask CRT.

- It produces wide range of colors as compared to beam-penetration technique.
- This technique is generally used in raster scan displays. Including color TV.
- In this technique CRT has three phosphor color dots at each pixel position. One dot for red, one for green and one for blue light. This is commonly known as **Dot Triangle**.
- Here in CRT there are three electron guns present, one for each color dot. And a shadow mask grid just behind the phosphor coated screen.
- The shadow mask grid consists of series of holes aligned with the phosphor dot pattern.
- Three electron beams are deflected and focused as a group onto the shadow mask and when they pass through a hole they excite a dot triangle.
- In dot triangle three phosphor dots are arranged so that each electron beam can activate only its corresponding color dot when it passes through the shadow mask.
- A dot triangle when activated appears as a small dot on the screen which has color of combination of three small dots in the dot triangle.
- By changing the intensity of the three electron beams we can obtain different colors in the shadow mask CRT.

Direct-view storage tubes (DVST)

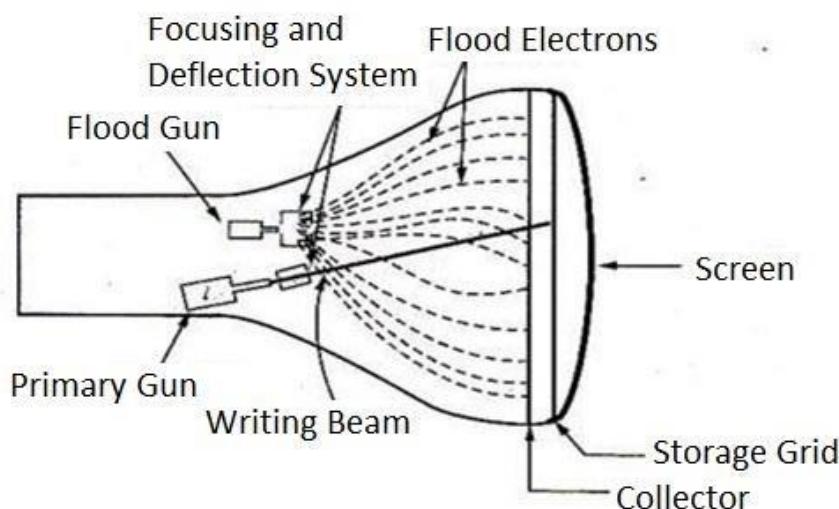


Fig. 1.7: - Direct-view storage tube.

- In raster scan display we do refreshing of the screen to maintain a screen image.
- DVST gives alternative method for maintaining the screen image.
- DVST uses the storage grid which stores the picture information as a charge distribution just behind the phosphor coated screen.
- DVST consists two electron guns a primary gun and a flood gun.
- A primary gun stores the picture pattern and the flood gun maintains the picture display.
- A primary gun emits high speed electrons which strike on the storage grid to draw the picture pattern.
- As electron beam strikes on the storage grid with high speed, it knocks out electrons from the storage grid keeping the net positive charge.
- The knocked out electrons are attracted towards the collector.
- The net positive charge on the storage grid is nothing but the picture pattern.
- The continuous low speed electrons from flood gun pass through the control grid and are attracted to

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the positive charged area of the storage grid.

- The low speed electrons then penetrate the storage grid and strike the phosphor coating without affecting the positive charge pattern on the storage grid.
- During this process the collector just behind the storage grid smooth out the flow of flood electrons.

Advantage of DVST

- Refreshing of CRT is not required.
- Very complex pictures can be displayed at very high resolution without flicker.
- Flat screen.

Disadvantage of DVST

- They do not display color and are available with single level of line intensity.
- For erasing it is necessary to removal of charge on the storage grid so erasing and redrawing process take several second.
- Erasing selective part of the screen cannot be possible.
- Cannot used for dynamic graphics application as on erasing it produce unpleasant flash over entire screen.
- It has poor contrast as a result of the comparatively low accelerating potential applied to the flood electrons.
- The performance of DVST is somewhat inferior to the refresh CRT.

Flat Panel Display

- The term flat panel display refers to a class of video device that have reduced volume, weight & power requirement compared to a CRT.
- As flat panel display is thinner than CRTs, we can hang them on walls or wear on our wrists.
- Since we can even write on some flat panel displays they will soon be available as pocket notepads.
- We can separate flat panel display in two categories:
 1. **Emissive displays:** - the emissive display or **emitters** are devices that convert electrical energy into light. For Ex. Plasma panel, thin film electroluminescent displays and light emitting diodes.
 2. **Non emissive displays:** - non emissive display or **non emitters** use optical effects to convert sunlight or light from some other source into graphics patterns. For Ex. LCD (Liquid Crystal Display).

Plasma Panels displays

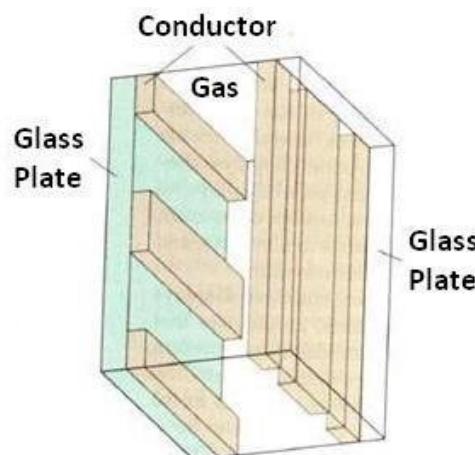


Fig. 1.8: - Basic design of a plasma-panel display device.

- This is also called gas discharge displays.
- It is constructed by filling the region between two glass plates with a mixture of gases that usually includes neon.
- A series of vertical conducting ribbons is placed on one glass panel and a set of horizontal ribbon is built into the other glass panel.
- Firing voltage is applied to a pair of horizontal and vertical conductors cause the gas at the intersection of the two conductors to break down into glowing plasma of electrons and ions.
- Picture definition is stored in a refresh buffer and the firing voltages are applied to refresh the pixel positions, 60 times per second.
- Alternating current methods are used to provide faster application of firing voltages and thus brighter displays.
- Separation between pixels is provided by the electric field of conductor.
- One disadvantage of plasma panels is they were strictly monochromatic device that means shows only one color other than black like black and white.

Thin Film Electroluminescent Displays.

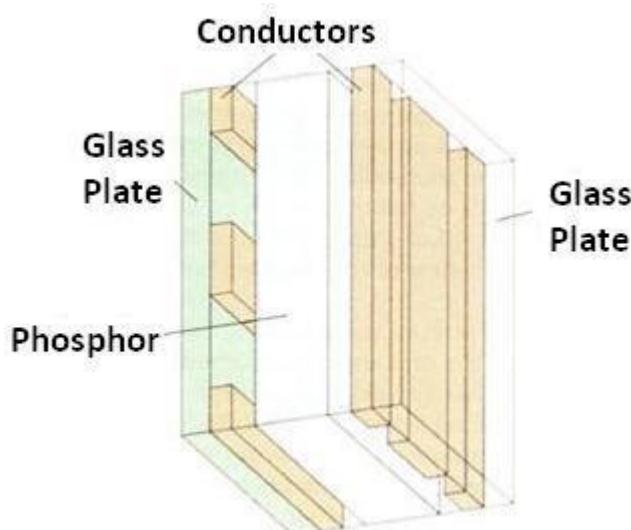


Fig. 1.9: - Basic design of a thin-film electro luminescent display device.

- It is similar to plasma panel display but region between the glass plates is filled with phosphors such as zinksulphide doped with magnesium instead of gas.
- When sufficient voltage is applied the phosphors becomes a conductor in area of intersection of the two electrodes.
- Electrical energy is then absorbed by the manganese atoms which then release the energy as a spot of light similar to the glowing plasma effect in plasma panel.
- It requires more power than plasma panel.
- In this good color and gray scale difficult to achieve.

Light Emitting Diode (LED)

- In this display a matrix of multi-color light emitting diode is arranged to form the pixel position in the display. And the picture definition is stored in refresh buffer.
- Similar to scan line refreshing of CRT information is read from the refresh buffer and converted to voltage levels that are applied to the diodes to produce the light pattern on the display.

Liquid Crystal Display (LCD)

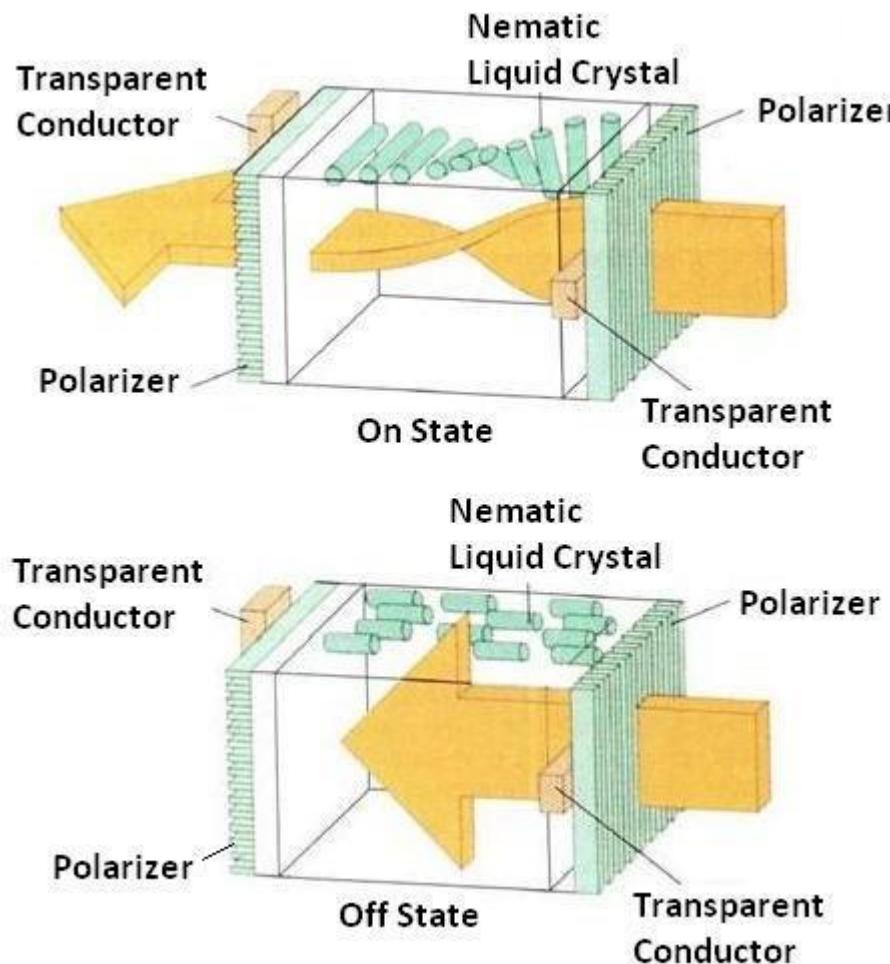


Fig. 1.10: - Light twisting shutter effect used in design of most LCD.

- It is generally used in small system such as calculator and portable laptop.
- This non emissive device produce picture by passing polarized light from the surrounding or from an internal light source through liquid crystal material that can be aligned to either block or transmit the light.
- The liquid crystal refreshes to fact that these compounds have crystalline arrangement of molecules then also flows like liquid.
- It consists of two glass plates each with light polarizer at right angles to each other sandwich the liquid crystal material between the plates.
- Rows of horizontal transparent conductors are built into one glass plate, and column of vertical conductors are put into the other plates.
- The intersection of two conductors defines a pixel position.
- In the ON state polarized light passing through material is twisted so that it will pass through the opposite polarizer.
- In the OFF state it will reflect back towards source.
- We applied a voltage to the two intersecting conductor to align the molecules so that the light is not twisted.
- This type of flat panel device is referred to as a passive matrix LCD.
- In active matrix LCD transistors are used at each (x, y) grid point.

- Transistor cause crystal to change their state quickly and also to control degree to which the state has been changed.
- Transistor can also serve as a memory for the state until it is changed.
- So transistor make cell ON for all time giving brighter display then it would be if it had to be refresh periodically

Advantages of LCD display

- Low cost.
- Low weight.
- Small size
- Low power consumption.

Three dimensional viewing devices

- The graphics monitor which are display three dimensional scenes are devised using a technique that reflects a CRT image from a vibrating flexible mirror.

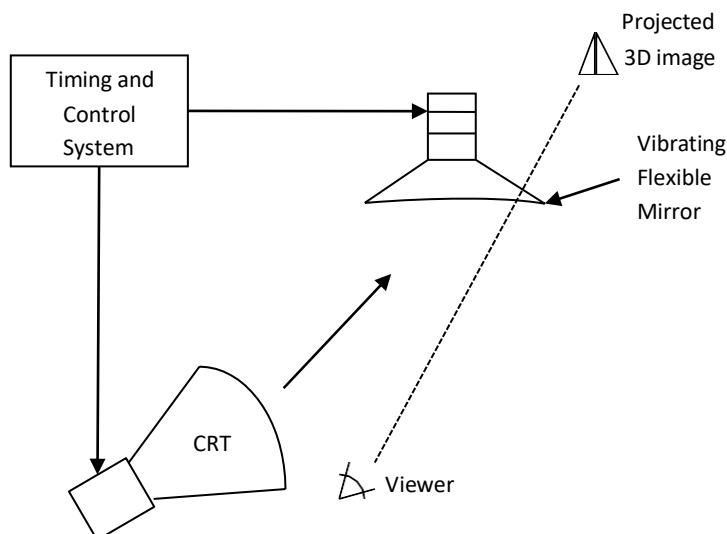


Fig. 1.11: - 3D display system uses a vibrating mirror.

- Vibrating mirror changes its focal length due to vibration which is synchronized with the display of an object on CRT.
- The each point on the object is reflected from the mirror into spatial position corresponding to distance of that point from a viewing position.
- Very good example of this system is GENISCO SPACE GRAPH system, which use vibrating mirror to project 3D objects into a 25 cm by 25 cm by 25 cm volume. This system is also capable to show 2D cross section at different depth.

Application of 3D viewing devices

- In medical to analyze data from ultra-sonography.
- In geological to analyze topological and seismic data.
- In designing like solid objects viewing and 3D viewing of objects.

Stereoscopic and virtual-reality systems

Stereoscopic system

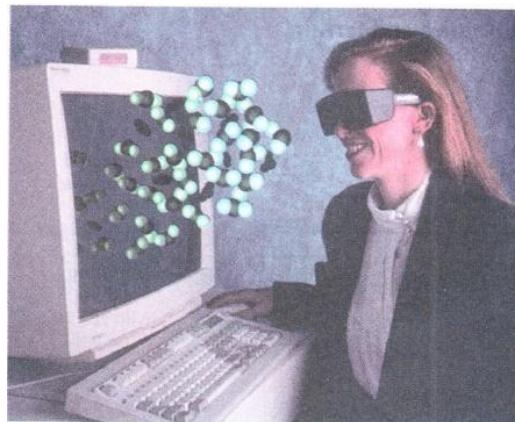


Fig. 1.12: - stereoscopic views.

- Stereoscopic views does not produce three dimensional images, but it produce 3D effects by presenting different view to each eye of an observer so that it appears to have depth.
- To obtain this we first need to obtain two views of object generated from viewing direction corresponding to each eye.
- We can construct the two views as computer generated scenes with different viewing positions or we can use stereo camera pair to photograph some object or scene.
- When we see simultaneously both the view as left view with left eye and right view with right eye then two views merge and produce image which appears to have depth.
- One way to produce stereoscopic effect is to display each of the two views with raster system on alternate refresh cycles.
- The screen is viewed through glasses with each lance design such a way that it act as a rapidly alternating shutter that is synchronized to block out one of the views.

Virtual-reality



Fig. 1.13: - virtual reality.

- Virtual reality is the system which produce images in such a way that we feel that our surrounding is what we are set in display devices but in actually it does not.
- In virtual reality user can step into a scene and interact with the environment.

- A head set containing an optical system to generate the stereoscopic views is commonly used in conjunction with interactive input devices to locate and manipulate objects in the scene.
- Sensor in the head set keeps track of the viewer's position so that the front and back of objects can be seen as the viewer "walks through" and interacts with the display.
- Virtual reality can also be produced with stereoscopic glass and video monitor instead of head set. This provides low cost virtual reality system.
- Sensor on display screen track head position and accordingly adjust image depth.

Raster graphics systems

Simple raster graphics system

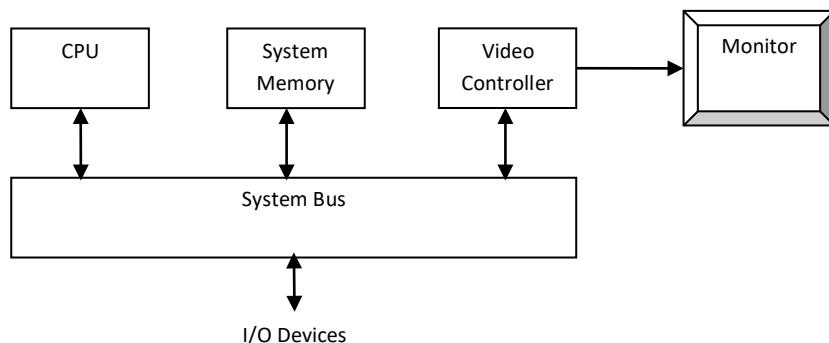


Fig. 1.14: - Architecture of a simple raster graphics system.

- Raster graphics systems having additional processing unit like video controller or display controller.
- Here frame buffer can be anywhere in the system memory and video controller access this for refresh the screen.
- In addition to video controller more processors are used as co-processors to accelerate the system in sophisticated raster system.

Raster graphics system with a fixed portion of the system memory reserved for the frame buffer

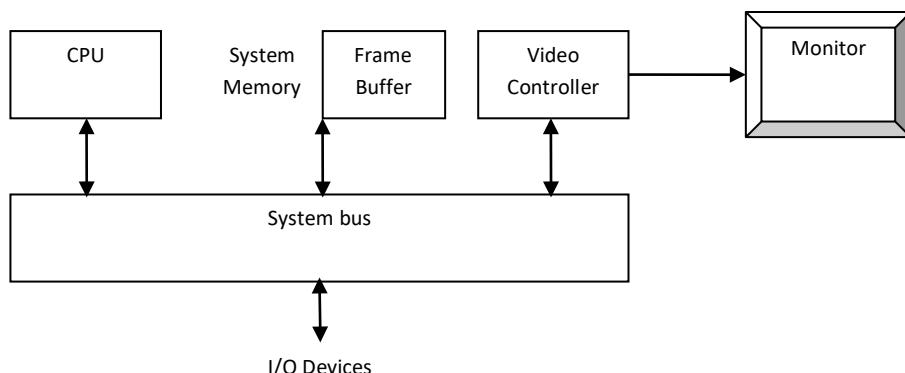


Fig. 1.15: - Architecture of a raster graphics system with a fixed portion of the system memory reserved for the frame buffer.

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- A fixed area of the system memory is reserved for the frame buffer and the video controller can directly access that frame buffer memory.
- Frame buffer location and the screen position are referred in Cartesian coordinates.
- For many graphics monitors the coordinate origin is defined at the lower left screen corner.
- Screen surface is then represented as the first quadrant of the two dimensional systems with positive X-value increases as left to right and positive Y-value increases bottom to top.

Basic refresh operation of video controller

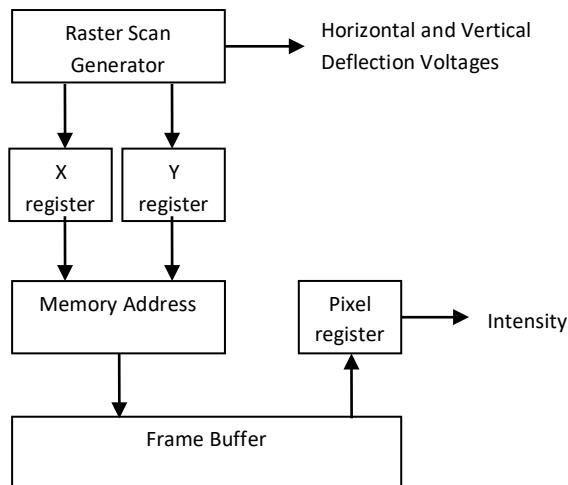


Fig. 1.16: - Basic video controller refresh operation.

- Two registers are used to store the coordinates of the screen pixels which are X and Y
- Initially the X is set to 0 and Y is set to Ymax.
- The value stored in frame buffer for this pixel is retrieved and used to set the intensity of the CRT beam.
- After this X register is incremented by one.
- This procedure is repeated till X becomes equals to Xmax.
- Then X is set to 0 and Y is decremented by one pixel and repeat above procedure.
- This whole procedure is repeated till Y is become equals to 0 and complete the one refresh cycle. Then controller reset the register as top –left corner i.e. X=0 and Y=Ymax and refresh process start for next refresh cycle.
- Since screen must be refreshed at the rate of 60 frames per second the simple procedure illustrated in figure cannot be accommodated by typical RAM chips.
- To speed up pixel processing video controller retrieves multiple values at a time using more numbers of registers and simultaneously refresh block of pixel.
- Such a way it can speed up and accommodate refresh rate more than 60 frames per second.

Raster-graphics system with a display processor

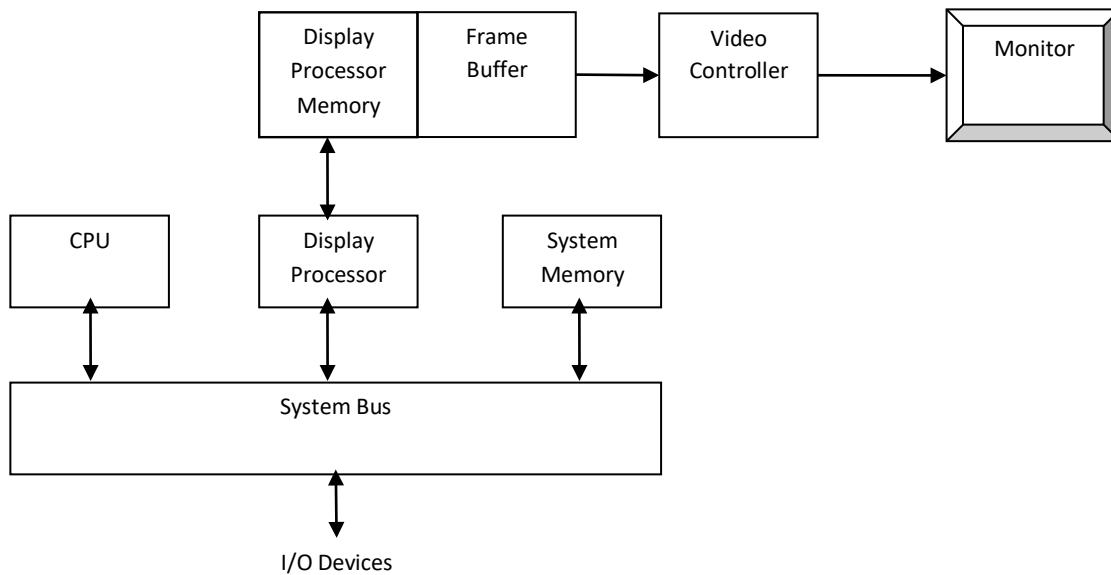


Fig. 1.17: - Architecture of a raster-graphics system with a display processor.

- One way to designing raster system is having separate display coprocessor.
- Purpose of display processor is to free CPU from graphics work.
- Display processors have their own separate memory for fast operation.
- Main work of display processor is digitalizing a picture definition given into a set of pixel intensity values for store in frame buffer.
- This digitalization process is scan conversion.
- Display processor also performs many other functions such as generating various line styles (dashed, dotted, or solid). Display color areas and performing some transformation for manipulating object.
- It also interfaces with interactive input devices such as mouse.
- For reduce memory requirements in raster scan system methods have been devised for organizing the frame buffer as a line list and encoding the intensity information.
- One way to do this is to store each scan line as a set of integer pair one number indicate number of adjacent pixels on the scan line that are having same intensity and second stores intensity value this technique is called run-length encoding.
- A similar approach is when pixel. Intensity is changes linearly, encoded the raster as a set of rectangular areas (cell encoding).
- Disadvantages of encoding is when run length is small it requires more memory then original frame buffer.
- It also difficult for display controller to process the raster when many sort runs are involved.

Random- scan system

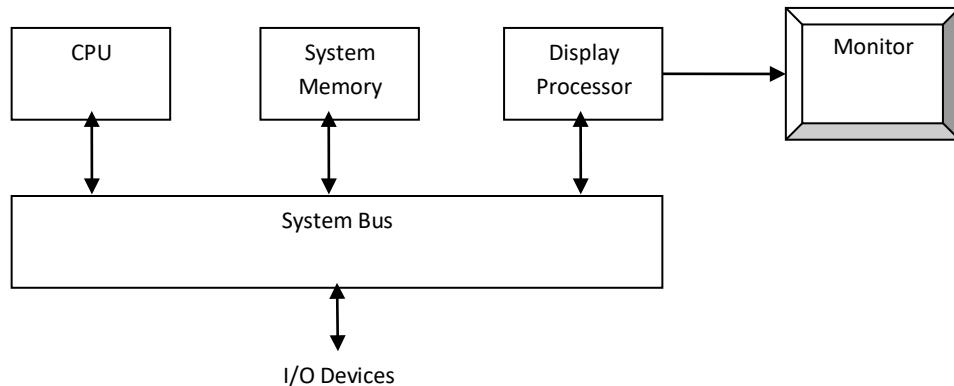


Fig. 1.18: - Architecture of a simple random-scan system.

- An application program is input & stored in the system memory along with a graphics package.
- Graphics commands in the application program are translated by the graphics package into a display file stored in the system memory.
- This display file is used by display processor to refresh the screen.
- Display process goes through each command in display file. Once during every refresh cycle.
- Sometimes the display processor in random scan system is also known as display processing unit or a graphics controller.
- In this system graphics platform are drawn on random scan system by directing the electron beam along the component times of the picture.
- Lines are defined by coordinate end points.
- This input coordinate values are converts to X and Y deflection voltages.
- A scene is then drawn one line at a time.

Graphics input devices

Keyboards

- Keyboards are used as entering text strings. It is efficient devices for inputting such a non-graphics data as picture label.
- Cursor control key's & function keys are common features on general purpose keyboards.
- Many other application of key board which we are using daily used of computer graphics are commanding & controlling through keyboard etc.

Mouse

- Mouse is small size hand-held box used to position screen cursor.
- Wheel or roller or optical sensor is directing pointer on the according to movement of mouse.
- Three buttons are placed on the top of the mouse for signaling the execution of some operation.
- Now a day's more advance mouse is available which are very useful in graphics application for example Z mouse.

Trackball and Spaceball

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- Trackball is ball that can be rotated with the finger or palm of the hand to produce cursor movement.

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- Potentiometer attached to the ball, measure the amount and direction of rotation.
- They are often mounted on keyboard or Z mouse.
- Space ball provide six-degree of freedom i.e. three dimensional.
- In space ball strain gauges measure the amount of pressure applied to the space ball to provide input for spatial positioning and orientation as the ball is pushed or pulled in various directions.
- Space balls are used in 3D positioning and selection operations in virtual reality system, modeling, animation, CAD and other application.

Joysticks

- A joy stick consists of small vertical lever mounted on a base that is used to steer the screen cursor around.
- Most joy sticks selects screen positioning according to actual movement of stick (lever).
- Some joy sticks are works on pressure applied on sticks.
- Sometimes joy stick mounted on keyboard or sometimes used alone.
- Movement of the stick defines the movement of the cursor.
- In pressure sensitive stick pressure applied on stick decides movement of the cursor. This pressure is measured using strain gauge.
- This pressure sensitive joy sticks also called as isometric joy sticks and they are non movable sticks.

Data glove

- Data glove is used to grasp virtual objects.
- The glow is constructed with series of sensors that detect hand and figure motions.
- Electromagnetic coupling is used between transmitter and receiver antennas which used to provide position and orientation of the hand.
- Transmitter & receiver Antenna can be structured as a set of three mutually perpendicular coils forming 3D Cartesian coordinates system.
- Input from the glove can be used to position or manipulate object in a virtual scene.

Digitizer

- Digitizer is common device for drawing painting or interactively selecting coordinates position on an object.
- One type of digitizers is graphics tablet which input two dimensional coordinates by activating hand cursor or stylus at selected position on a flat surface.
- Stylus is flat pencil shaped device that is pointed at the position on the tablet.

Image Scanner

- Image Scanner scan drawing, graph, color, & black and white photos or text and can stored for computer processing by passing an optical scanning mechanism over the information to be stored.
- Once we have internal representation of a picture we can apply transformation.
- We can also apply various image processing methods to modify the picture.
- For scanned text we can apply modification operation.

Touch Panels

- As name suggest Touch Panels allow displaying objects or screen-position to be selected with the touch or finger.

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- A typical application is selecting processing option shown in graphical icons.

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- Some system such as a plasma panel are designed with touch screen
- Other system can be adapted for touch input by fitting transparent touch sensing mechanism over a screen.
- Touch input can be recorded with following methods.
 1. Optical methods
 2. Electrical methods
 3. Acoustical methods

Optical method

- Optical touch panel employ a line of infrared LEDs along one vertical and one horizontal edge.
- The opposite edges of the edges containing LEDs are contain light detectors.
- When we touch at a particular position the line of light path breaks and according to that breaking line coordinate values are measured.
- In case two line cuts it will take average of both pixel positions.
- LEDs operate at infrared frequency so it cannot be visible to user.

Electrical method

- An electrical touch panel is constructed with two transparent plates separated by small distance.
- One is coated with conducting material and other is coated with resistive material.
- When outer plate is touch it will come into contact with internal plate.
- When both plates touch it creates voltage drop across the resistive plate that is converted into coordinate values of the selected position.

Acoustical method

- In acoustical touch panel high frequency sound waves are generated in horizontal and vertical direction across a glass plates.
- When we touch the screen the waves from that line are reflected from finger.
- These reflected waves reach again at transmitter position and time difference between sending and receiving is measure and converted into coordinate values.

Light pens

- Light pens are pencil-shaped device used to select positions by detecting light coming from points on the CRT screen.
- Activated light pens pointed at a spot on the screen as the electron beam lights up that spot and generate electronic pulse that causes the coordinate position of the electron beam to be recorded.

Voice systems

- It is used to accept voice command in some graphics workstations.
- It is used to initiate graphics operations.
- It will match input against predefined directory of words and phrases.
- Dictionary is setup for a particular operator by recording his voice.
- Each word is speak several times and then analyze the word and establishes a frequency pattern for that word along with corresponding function need to be performed.
- When operator speaks command it will match with predefine dictionary and perform desired action.

Graphics software and standard

- There are mainly two types of graphics software:
 1. General programming package
 2. Special-purpose application package

General programming package

- A general programming package provides an extensive set of graphics function that can be used in high level programming language such as C or FORTRAN.
- It includes basic drawing element shape like line, curves, polygon, color of element transformation etc.
- Example: - GL (Graphics Library).

Special-purpose application package

- Special-purpose application package are customize for particular application which implement required facility and provides interface so that user need not to worry about how it will work (programming). User can simply use it by interfacing with application.
- Example: - CAD, medical and business systems.

Coordinate representations

- Except few all other general packages are designed to be used with Cartesian coordinate specifications.
- If coordinate values for a picture are specified in some other reference frame they must be converted to Cartesian coordinate before giving input to graphics package.
- Special-purpose package may allow use of other coordinates which suits application.
- In general several different Cartesian reference frames are used to construct and display scene.
- We can construct shape of object with separate coordinate system called modeling coordinates or sometimes local coordinates or master coordinates.
- Once individual object shapes have been specified we can place the objects into appropriate positions called world coordinates.
- Finally the World-coordinates description of the scene is transferred to one or more output device reference frame for display. These display coordinates system are referred to as "**Device Coordinates**" or "**Screen Coordinates**".
- Generally a graphic system first converts the world-coordinates position to normalized device coordinates. In the range from 0 to 1 before final conversion to specific device coordinates.
- An initial modeling coordinates position (X_{mc},Y_{mc}) in this illustration is transferred to a device coordinates position(X_{dc},Y_{dc}) with the sequence (X_{mc},Y_{mc}) → (X_{wc},Y_{wc}) → (X_{nc},Y_{nc}) → (X_{dc},Y_{dc}).

Graphic Function

- A general purpose graphics package provides user with Variety of function for creating and manipulating pictures.
- The basic building blocks for pictures are referred to as output primitives. They includes character, string, and geometry entities such as point, straight lines, curved lines, filled areas and shapes defined with arrays of color points.
- Input functions are used for control & process the various input device such as mouse, tablet, etc.
- Control operations are used to controlling and housekeeping tasks such as clearing display screen etc.
- All such inbuilt function which we can use for our purpose are known as graphics function

Software Standard

- Primary goal of standardize graphics software is portability so that it can be used in any hardware systems & avoid rewriting of software program for different system
- Some of these standards are discuss below

Graphical Kernel System (GKS)

- This system was adopted as a first graphics software standard by the international standard organization (ISO) and various national standard organizations including ANSI.
- GKS was originally designed as the two dimensional graphics package and then later extension was developed for three dimensions.

PHIGS (Programmer's Hierarchical Interactive Graphic Standard)

- PHIGS is extension of GKS. Increased capability for object modeling, color specifications, surface rendering, and picture manipulation are provided in PHIGS.
- Extension of PHIGS called “**PHIGS+**” was developed to provide three dimensional surface shading capabilities not available in PHIGS.