COMPUTER GRAPHICS & IMAGE PROCESSING

**Module 1** **Part 1**
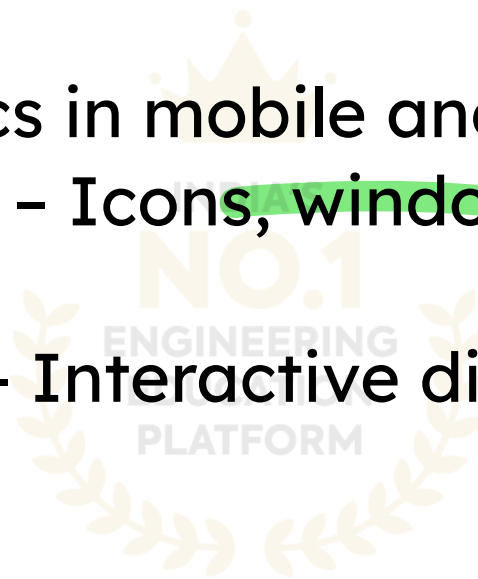
FRANKLIN'S LECTURES

CST 304

Module – 1(Basics of Computer graphics and Algorithms)
Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems. Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm.
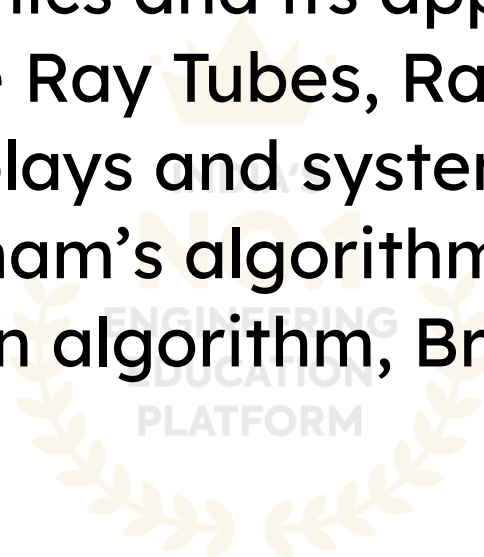
PRACTICAL APPLICATION

- Animation & Movies – Pixar, Disney, CGI effects use computer graphics.
  - Gaming – 2D/3D graphics in mobile and PC games.
  - User Interfaces (UI/UX) – Icons, windows, buttons in operating systems.
  - Education & E-learning – Interactive diagrams, simulations.

- 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.
  Two types:
- Interactive computer graphics
- Non-interactive computer graphics

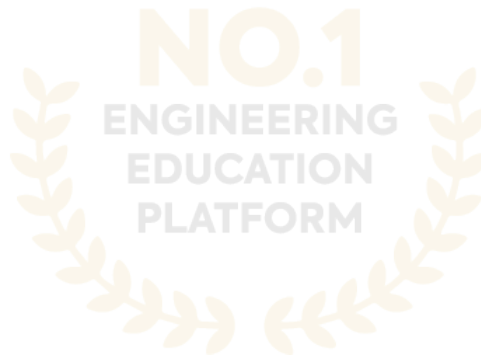Pixels → Tiny squares or dots

eg:

1920 × 1080

Total pixels =

INTERACTIVE COMPUTER GRAPHICS

- Two-way communication: Allows the user to provide input and see the image change in response.
- User control: The user can modify, manipulate, or interact with the image using input devices like a mouse, keyboard, or touchscreen.
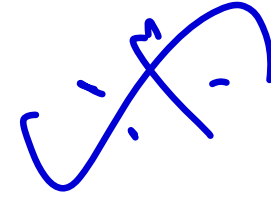 Examples:
- Video games

NON-INTERACTIVE COMPUTER GRAPHICS

- One-way communication: The image is pre-rendered and sent to the user without any ability for the user to change it.
- No user control: The user cannot make changes to the image once it has been generated.
- Examples:

Images on a website

Computer → User

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.

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
- 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.

- **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.
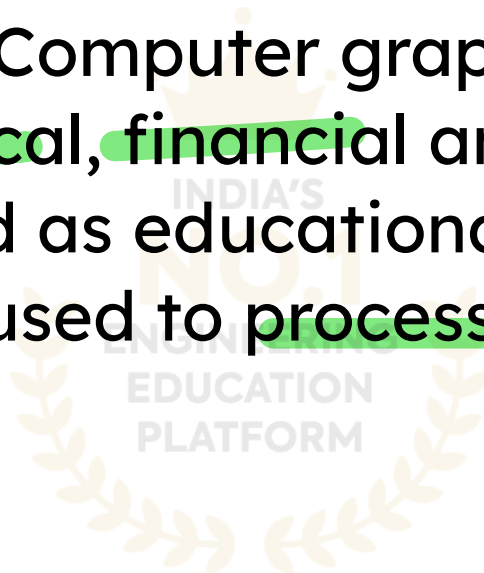
PIXEL

- A pixel, short for "picture element," is the smallest point or dot that can be displayed on a screen.
- Function: Each pixel is assigned a specific color and brightness, and the combination of all pixels forms the complete image.

Resolution

- Definition: Resolution is the number of pixels in both the horizontal and vertical dimensions of the screen.
- Expression: It is expressed as a pair of numbers, such as (Full HD), where the first number is the width in pixels and the second is the height

eg → 1920 × 1080

1920 → pixels horizontally

1080 → pixels vertically

Aspect Ratio

- Definition: The aspect ratio is the ratio of an image's width to its height.

- Expression: It is expressed as a ratio, such as 16:9 (widescreen) or 4:3 (older standard).

Q,Explain the pixel, resolution and aspect ratio of a display screen

(3,April 2025)

Q,List out the applications of computer graphics

(3,june 2023)

VIDEO DISPLAY DEVICES

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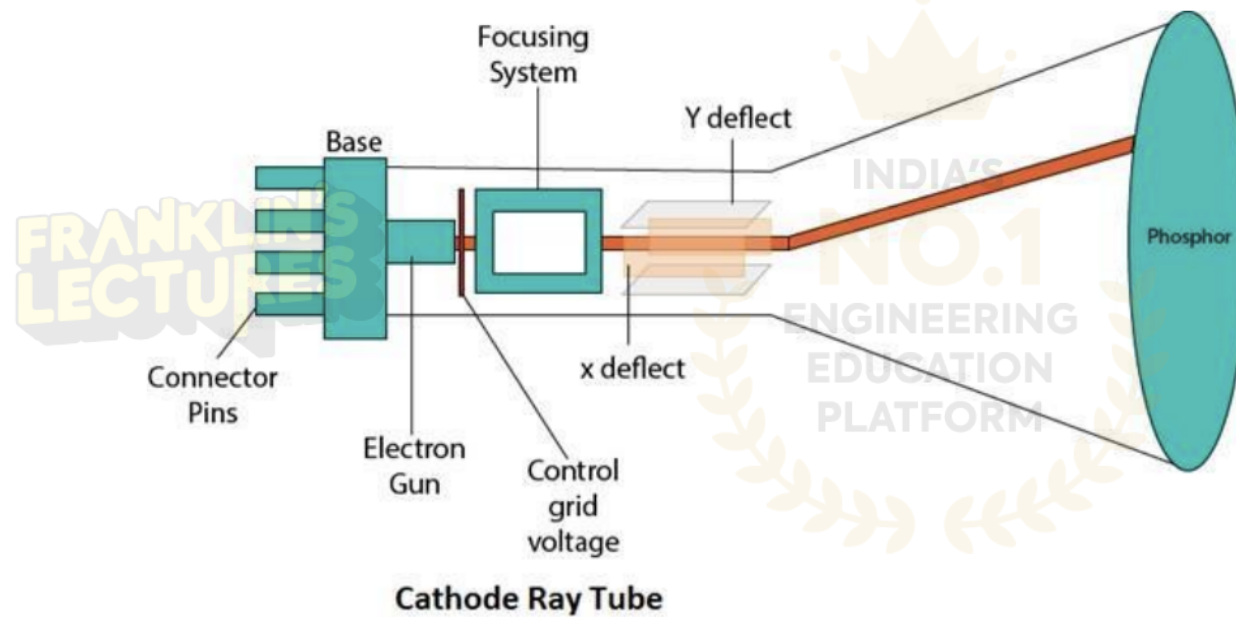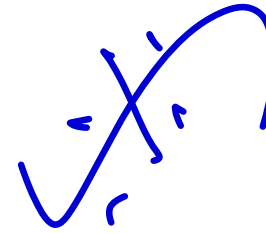- Most commonly used output device in a graphics system is a video monitor

Display devices
- Cathode-Ray Tube(CRT)
- Color CRT Monitor
- Liquid crystal display(LCD)
- Light Emitting Diode(LED)
- Direct View Storage Tubes(DVST)
- Plasma Display
- 3D Display

CATHODE-RAY-TUBES

Cathode Ray Tube

The basic CRT consists of 4 major components
- Electron gun
- Focusing and accelerating anode
- Horizontal and vertical deflection plates
- Evacuated glass envelop

- 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 bye 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.

vertical plates → moves beam from left to right

horizontal plates → moves beam up-down.

Advantages of CRT

- **High Contrast and Brightness** – CRTs can produce very bright images with a high contrast ratio, making them ideal for use in environments with variable lighting.
- **Wide Viewing Angles** – CRT displays do not suffer from the restricted viewing angles common in early LCDs, providing a consistent image quality from multiple perspectives.
- **Fast Response Time** – CRTs have near-instantaneous response times, which made them highly suitable for applications like gaming or scientific visualization.

Limitations of CRT

- **Bulky and Heavy** – CRTs are large and heavy, especially as screen sizes increase. This made them less practical for portable devices or for use in smaller spaces.

- **Power Consumption** – CRTs consume significantly more power than modern displays such as LED or LCD screens. This makes them less energy efficient and more expensive to operate over time.
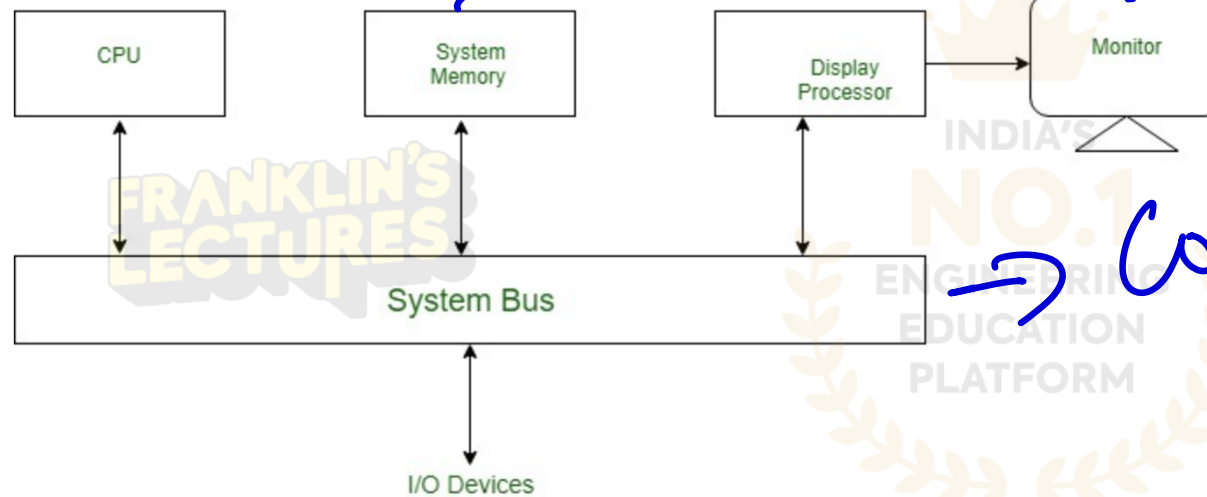
There are two techniques used for producing images on the CRT screen:

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

RANDOM SCAN DISPLAY

simple architecture

→ stores memory

→ final image display

→ Communication Pathway

CPU

System Memory

Display Processor

Monitor

System Bus

I/O Devices

- In Random-Scan Display electron beam is directed only to the areas of screen where a picture has to be drawn.
- It is also called vector display, as it draws picture one line at time. It can draw and refresh component lines of a picture in any specified sequence.
- A Pen plotter is an example of random-scan device.
- The number of lines regulates refresh rate on random-scan displays.
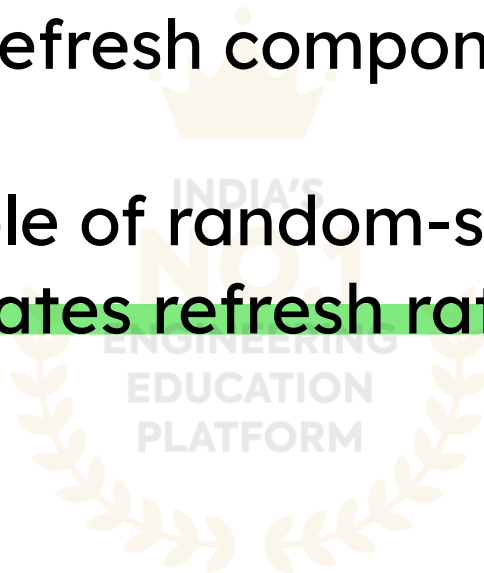
- Vector scan display directly traces out only the desired lines on CRT.
- If we want line between point p1 & p2 then we directly drive the beam deflection circuitry which focus beam directly from point p1 to p2.
- If we do not want to display line from p1 to p2 and just move then we can blank the beam 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.

- 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.
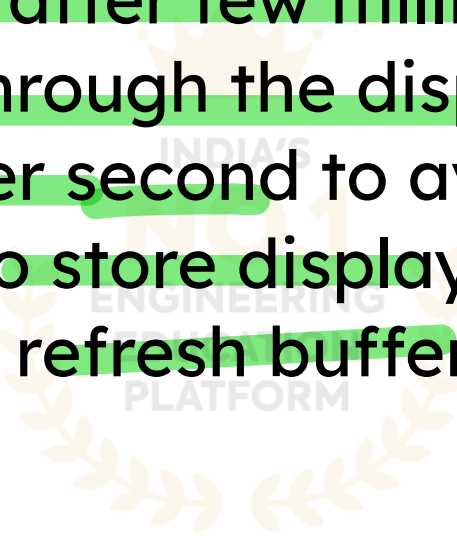
ADVANTAGES:
- Higher resolution as compared to raster scan display.
- Produces smooth line drawing.
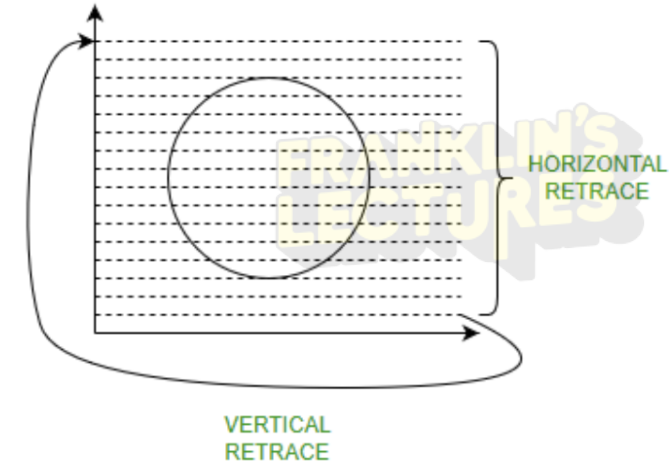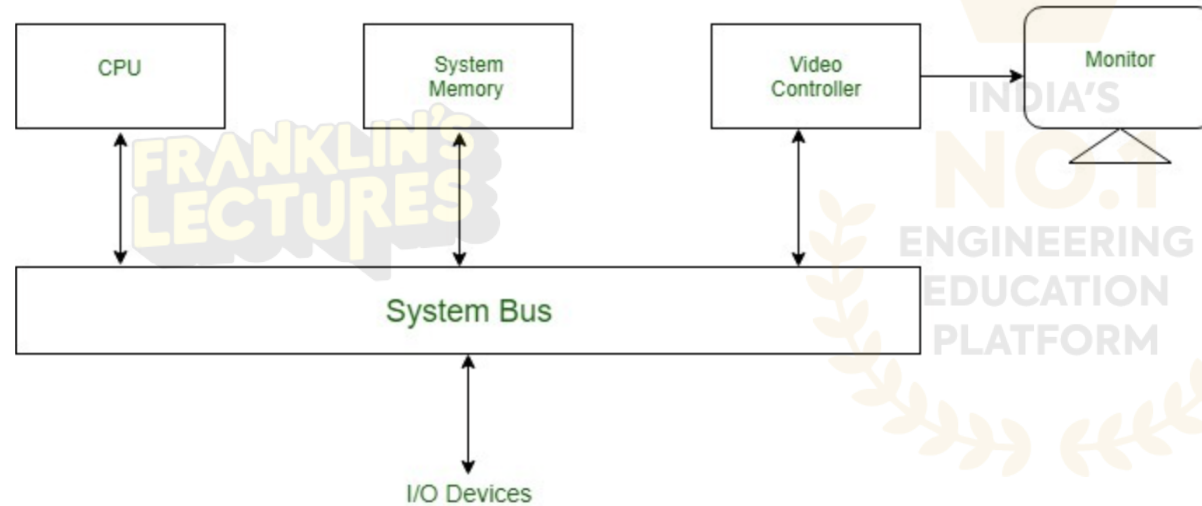- Less Memory required.

DISADVANTAGES:
- Realistic images with different shades cannot be drawn.
- Colour limitations.

RASTER SCAN DISPLAY

Simple architecture

- Raster Scan Displays are most common type of graphics monitor which employs CRT.
- It is based on television technology. In raster scan system electron beam sweeps across the screen, from top to bottom covering one row at a time.
- A pattern of illuminated pattern of spots is created by turning beam intensity on and off as it moves across each row. A memory area called refresh buffer or frame buffer stores picture definition.
- This memory area holds intensity values for all screen points.
- Stored intensity values are restored from frame buffer and painted on screen taking one row at a time.Each screen point is referred to as pixels.
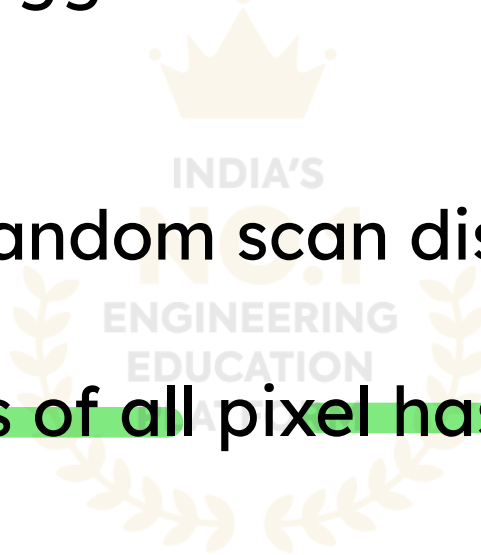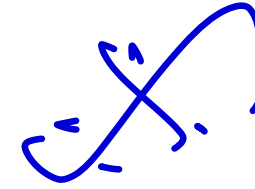
ON → Pixel Glows
Off → Pixel stays dark

ADVANTAGES:

- Real life images with different shades can be displayed.
- Color range available is bigger than random scan display.

DISADVANTAGES:

- Resolution is lower than random scan display.
- More memory is required.
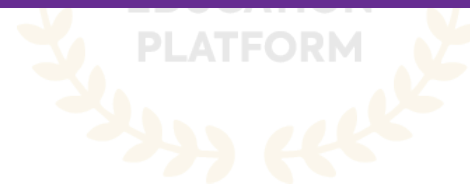- Data about the intensities of all pixel has to be stored.

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.

Q, Explain the Random Scan Display System in detail. How does it differ from the Raster Scan Display System?

(8,April 2025)

Q, Explain the architecture of raster scan system with suitable diagram

(6,June 2023)