Unit I: Computer Graphics and Hardware

This unit introduces the basics of computer graphics, its history, applications, and the hardware devices used for input and output in graphics systems.

1. History and Applications of Computer Graphics

Definition: Computer graphics refers to the creation, manipulation, and rendering of visual content using computers.

History:

- 1950s: Early computer graphics were simple line drawings.
- 1960s: Ivan Sutherland developed Sketchpad, the first interactive graphics system.
- 1980s: Advancements in raster graphics and 3D modeling.
- 1990s-Present: Real-time rendering, virtual reality, and photorealistic graphics.

Applications:

- Entertainment: Video games, movies, and animations.
- Education: Simulations and visual aids.
- Design: CAD (Computer-Aided Design) for engineering and architecture.
- Medical Imaging: MRI, CT scans, and 3D visualizations.
- User Interfaces: Graphical user interfaces (GUIs) for software.

2. Input Devices

Input devices are hardware components used to provide data and control signals to a computer.

Mouse: A pointing device used to interact with graphical user interfaces.

Example: Clicking and dragging objects on the screen.

Keyboard: Used to input text and commands.

Touch Panel: A touch-sensitive screen that detects finger input.

Example: Smartphones and ATMs.

Light Pen: A light-sensitive stylus used to draw on CRT screens.

Digitizer: Converts analog data (e.g., drawings) into digital format.

Example: Graphic tablets.

Data Glove: A wearable device that captures hand movements.

Example: Virtual reality applications.

Bar Code Reader: Scans barcodes to input data.

Example: Supermarket checkout systems.

OCR (Optical Character Recognition): Converts scanned text into editable text.

Example: Digitizing printed documents.

OMR (Optical Mark Recognition): Reads marked data (e.g., answer sheets).

MICR (Magnetic Ink Character Recognition): Reads characters printed with magnetic ink.

Example: Bank checks.

3. Hardcopy Output Devices

Hardcopy devices produce physical copies of digital content.

Printer:

Inkjet Printer: Sprays ink onto paper.

Laser Printer: Uses laser beams to transfer toner onto paper.

Example: Printing documents and photos.

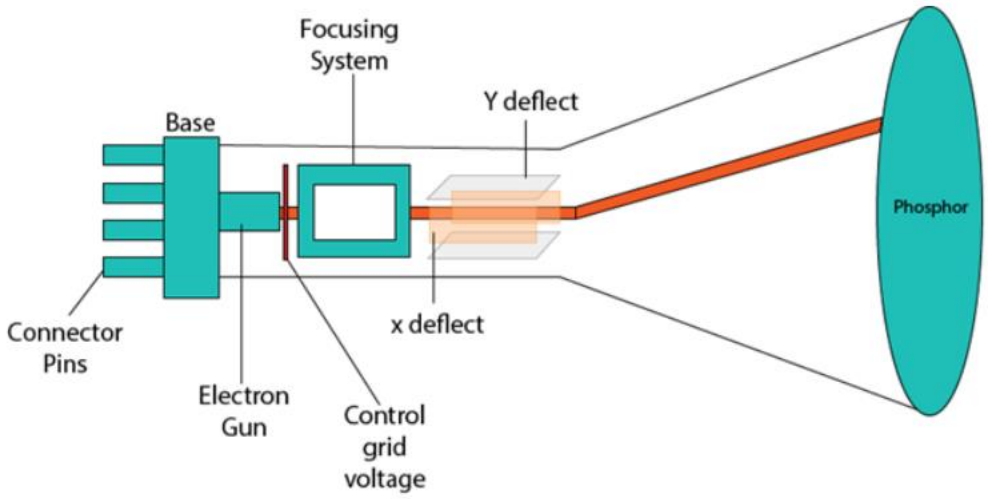
Plotter: Used for large-scale drawings, such as architectural plans.

Example: Vector graphics output.

4. Display Devices

Display devices are used to visually present digital content.

I. CRT (Cathode Ray Tube): Emissive display device(Converting Electrical energy to light energy).



Cathode Ray Tube

Monochrome

CRT: Displays single-color images (e.g., black and white).

Color CRT: Uses red, green, and blue phosphors to create color images.

Example: Old television and computer monitors.

II. LED (Light Emitting Diode): Emissive Display device. Uses LEDs for backlighting, offering energy efficiency and better color accuracy.Example: Modern TVs and monitors.

III. LCD (Liquid Crystal Display): Non-Emissive display device(Converting light energy to picture patterns). Uses liquid crystals to block or allow light.Example: Laptop screens and smartphones.

IV. Plasma Display: Emissive display device. Uses ionized gases to produce light.Example: Large-screen TVs.

5. Architecture of Raster Scan and Random Scan Systems

Differentiate between Random and Raster Scan Display:

Random Scan	Raster Scan
1. It has high Resolution	1. Its resolution is low.
2. It is more expensive	2. It is less expensive
3. Any modification if needed is easy	3.Modification is tough
4. Solid pattern is tough to fill	4.Solid pattern is easy to fill
5. Refresh rate depends or resolution	5. Refresh rate does not depend on the picture.
6. Only screen with view on an area is displayed.	6. Whole screen is scanned.
7. Beam Penetration technology come under it.	7. Shadow mark technology came under this.
8. It does not use interlacing method.	8. It uses interlacing
9. It is restricted to line drawing applications	9. It is suitable for realistic display.

Raster Scan System: Displays images by scanning the screen line by line, pixel by pixel.

Process: The electron beam moves across each row (scan line) from top to bottom.Pixels are illuminated based on the image data stored in the frame buffer. Example: Modern TVs and computer monitors.

Advantages: Realistic images, supports color and shading.
Disadvantages: Requires more memory and processing power.

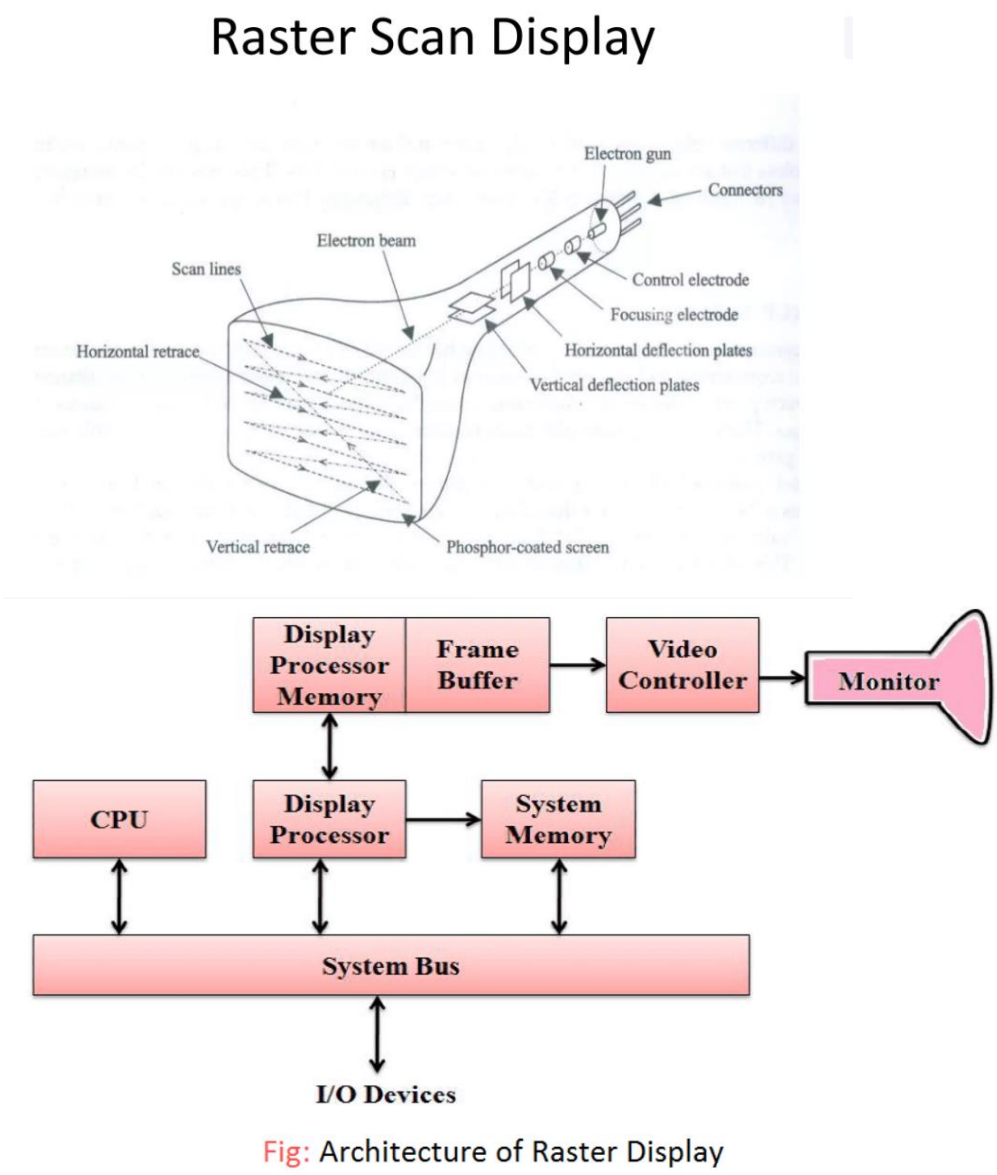


Fig: Architecture of Raster Display

Random Scan System: Displays images by drawing lines and shapes directly. Random-scan monitors are also known as vector displays or stroke-writing displays or calligraphic displays.

Process:

The electron beam moves randomly to draw lines and curves. Used for vector graphics. Example: Oscilloscopes and early CAD systems.

Advantages: High-resolution lines, less memory usage.
Disadvantages: Limited to line drawings, not suitable for complex images.

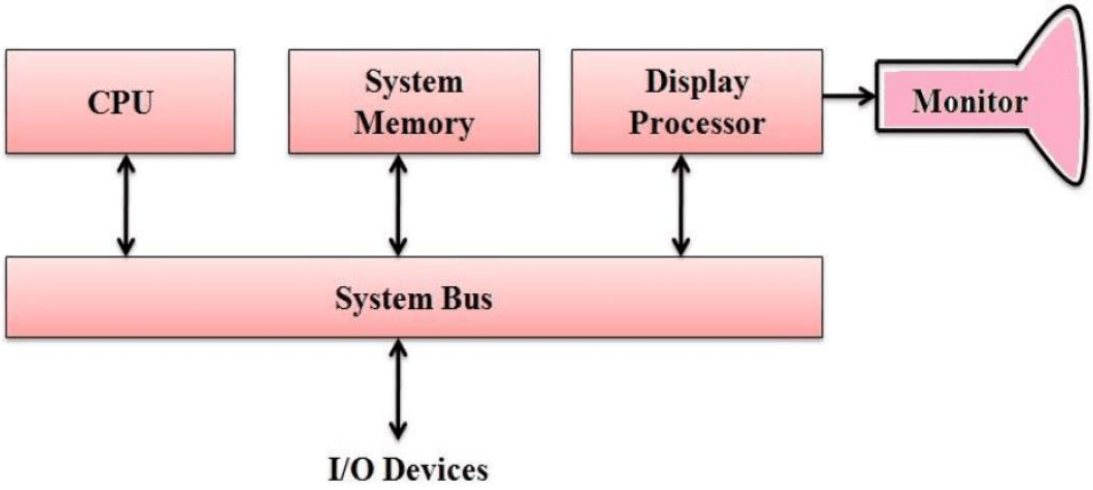


Fig: Architecture of Random Display

Define computer graphics? Why computer graphics is needed in human life. What are the application areas of computer graphics?

Computer Graphics is the field of computer science that deals with creating, manipulating, and displaying visual images using computers. It involves techniques for generating and modifying images, animations, and visual effects.

Why is Computer Graphics Needed in Human Life?

Computer graphics play an essential role in modern life because they help in:

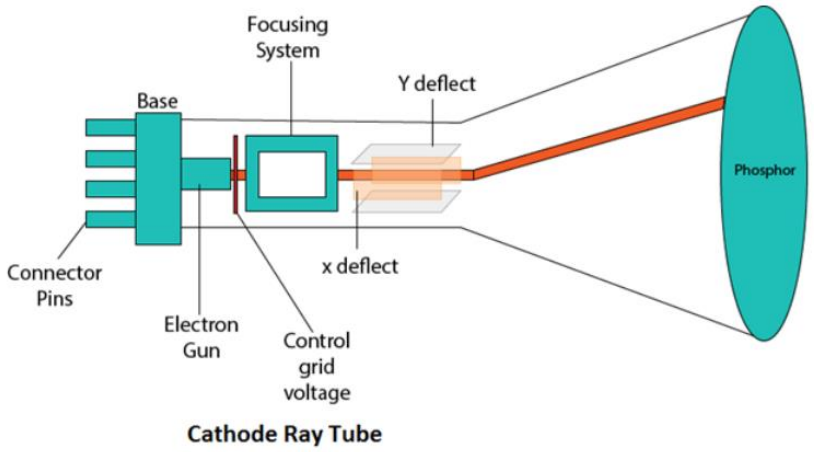
- Better Communication – Visual representation makes information easier to understand.
- Entertainment & Creativity – Used in movies, games, and animations.
- Realistic Simulations – Helps in training (e.g., flight simulators, medical imaging).
- Efficient Design & Development – Used in architecture, engineering, and product design.

Application Areas of Computer Graphics

- Entertainment – Movies, video games, animations.
- Education – E-learning, visual teaching aids.
- Medical Imaging – CT scans, MRI, and X-rays visualization.
- Engineering & Design – CAD software for architecture, mechanical design.
- Scientific Visualization – Graphs, simulations, weather forecasting.
- Virtual Reality & Augmented Reality – VR gaming, AR apps.
- Advertising & Media – Graphic design, digital marketing, and branding.

Explain the working principle of CRT Monitors?

Working Principle of CRT Monitor



Cathode Ray Tube

A CRT (Cathode Ray Tube) monitor works by using an electron beam to create images on a fluorescent screen.

How CRT Monitor Works?

1. **Emits electron:** A cathode (electron gun) at the back of the tube emits electrons.
2. **Focusing System:**
   The electrons are accelerated and focused into a thin beam using electromagnetic coils.
3. **Deflection System:**
   Horizontal and vertical deflection plates guide the electron beam to the correct position on the screen.
4. **Screen Illumination/ Phosphor coated Screen:**
   The screen is coated with phosphor, which glows when struck by electrons, producing an image.
   Different colors are produced using red, green, and blue (RGB) phosphors.
5. **Refreshing the Screen:**
   The process happens rapidly (usually 60–120 times per second), refreshing the image continuously.

Simple Difference Between Raster Scan and Random Scan System

Feature	Raster Scan System	Random Scan System
Resolution	Low resolution	High resolution
Scanning Method	Scans from **top to bottom**, **one row at a time on screen.**	Scans **only necessary end points (one line at a time).**
Technology Used	**Shadow mask technology** (for color displays)	**Beam penetration technology** (for color displays)
Memory Requirement	High (stores pixel data)	Low (stores only line equations)
Best For	**Realistic images** (TVs, games)	**Line drawings** (CAD, oscilloscopes)
Example Devices	LCD, LED, OLED screens	Oscilloscopes, Air Traffic Control screens
Modification	Not so Easy	Easy
Solid Pattern	Tough to Fill	Easy to Fill
Interlacing	Use interlacing method	Does not use interlacing method

Difference Between Shadow Mask and Beam Penetration Technology

Feature	Shadow Mask Technology	Beam Penetration Technology
Working Principle	Uses a **shadow mask** to direct electron beams to specific phosphor dots.	Uses **different electron beam intensities** to produce colors.
Color Production	Uses **RGB phosphors** to create a wide range of colors.	Uses **only two phosphor layers** (usually red and green).
Color Variety	Produces **millions of colors**.	Limited to **only a few colors** (red, green, yellow, orange).
Display Quality	High resolution, sharper images.	Low resolution, less detailed images.
Used In	CRT monitors, old TVs, arcade games.	Early vector displays, oscilloscopes.
Cost	More expensive.	Cheaper.