INTRODUCTION TO COMPUTER GRAPHICS

Tara Qadir
2024-2025
3rd Stage-first semester
Computer department
College of science
University of Sulymaniah

What is computer Graphics

Computer graphics are created using computers and, more generally, the representation and manipulation of image data by a computer with help from specialized software and hardware.

- **Creation, Manipulation, and Storage of geometric objects (modelling) and their images (rendering)**
- **Display those images on screens or hardcopy devices**
- **Image processing**
- **Others: GUI, Haptics, Displays (VR ,AR)...**

History of computer graphics

- **In 1960s : few company like IBM exist ,memory was in rang of kilobytes ,the only programing language support was assembler ,FORTRANT and Algol ,simple graphics like Function Graphs and snoopy calendar are done.**

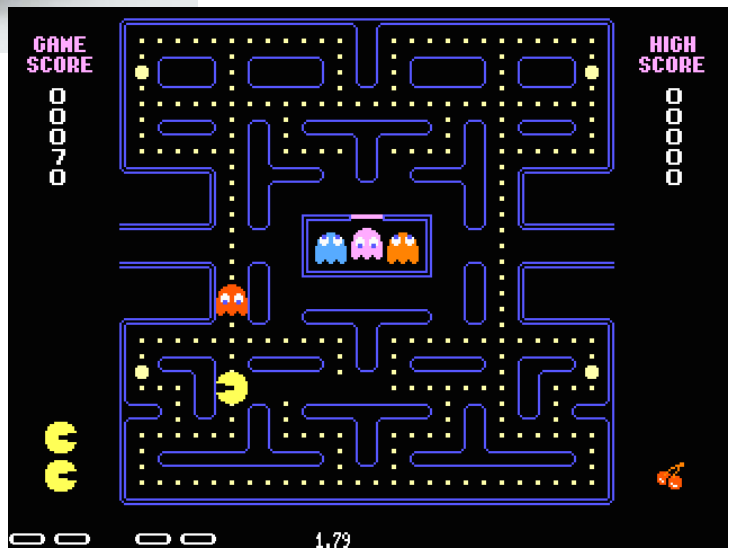
- **In early 70s :**

EVANS and SUTHERLAND picture system was the high end graphic system witch was vector display with hardware support with clipping and perspective , Xerox PARC introduced and 8 bit computer invented by Intel .

Late 70s: Apple 1, 2 are become first commercial personal computer , ping pong game become popular , laser printer invented.


PAC-MAN
MIDWAY'S


Ping
Pong


GAME
SCORE
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HIGH
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- **In early 80s: Video graphics Array (VGA) invented by IBM , Silicon Graphics (SGI) work station witch support real time raster line drawing and later polygon become CG desires.**

- **Late 80s: at NASA invented Data Glove, precursor to virtual reality**

- **90s : operating system, window system, application programing interface (API) that graphics used, laptop, massive of game players ,image based rendering become area of research.**

Graphics System

- Video Display Devices
  - Refresh Cathode-Ray Tubes (CRTs)
    - Raster-Scan Displays
    - Random-Scan Displays
  - Color CRT Monitors
  - Liquid crystal display(LCD)
  - Light Emitting Diode(LED)
  - Direct View Storage Tubes(DVST)
  - Plasma Display
  - 3D Display
- Graphics Workstations and Viewing Systems
- Input Devices
- Hard-copy Devices

Video Display Devices

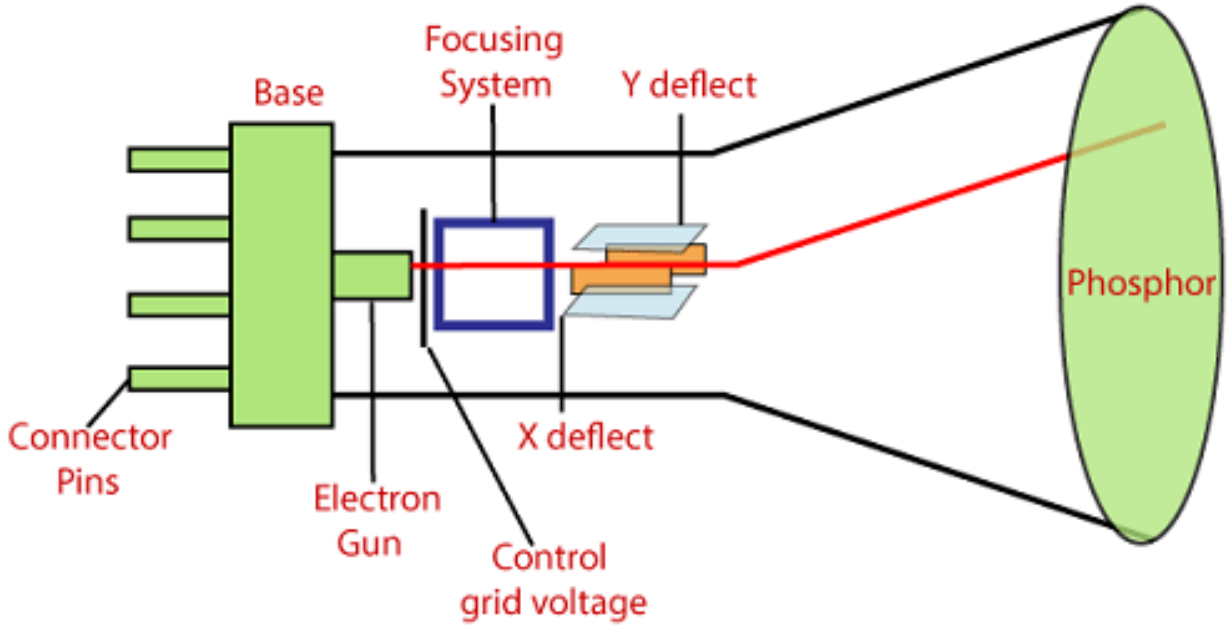
The primary output device in a graphics system is a video monitor. It is based on the standard cathode-ray tube (CRT) design.

1) CRT :

A beam of electrons , emitted by an electron gun, passed through focusing and deflection systems that direct the beam toward specified positions on the phosphor-coated screen.

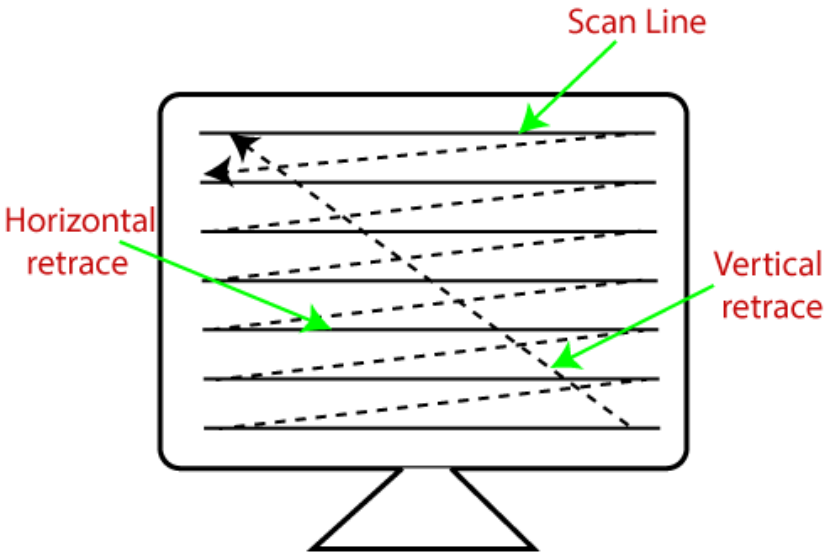
- **The phosphor emits a small spot of light at each position contacted by the electron beam**
- **The light emitted by the phosphor fades very rapidly**
- **the screen picture is maintained by directing the electron beam repeatedly over the same screen points**
- **This type of screen called refresh CRT and the frequency is called refresh rate**

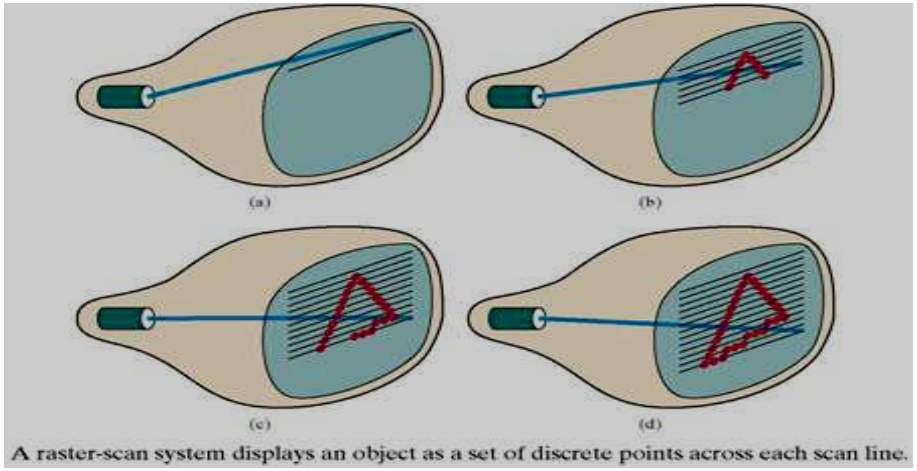
Video Display Devices (CRT)



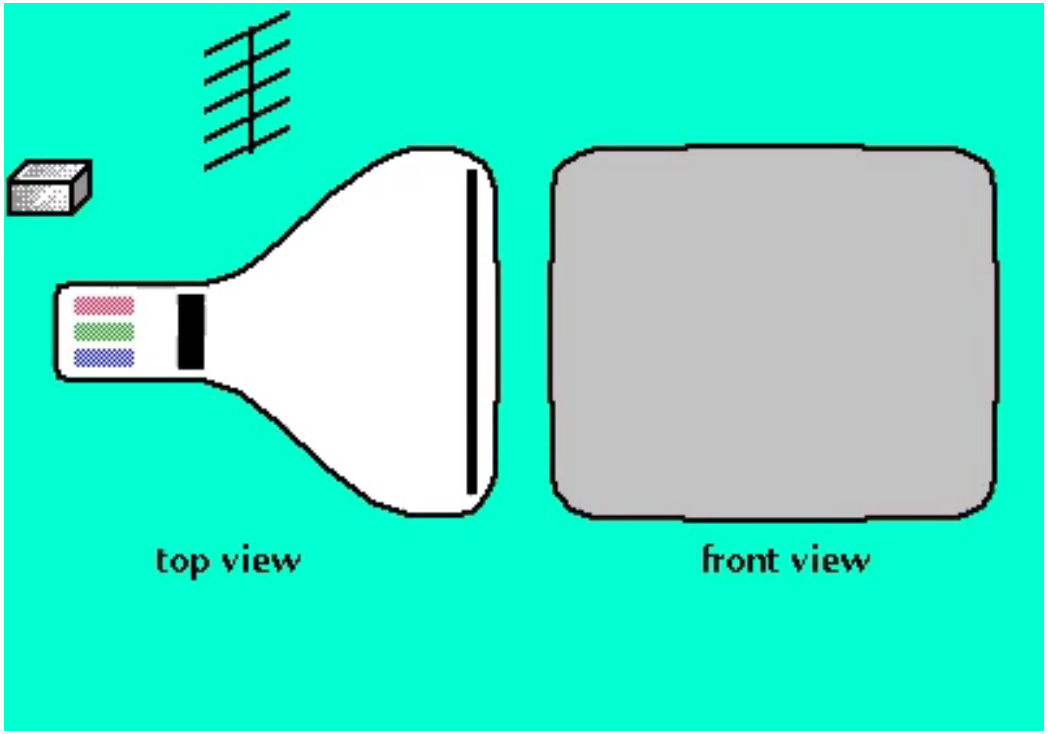
A)Raster – Scan Systems

- Most common type used in CRT, Based on television technology
- The electronic beam is swept across screen, one row at a time, from top to bottom, each row is referred to as a scan line
- As the electronic beam moves across a scan line, the beam intensity is turned on or off
- Picture definition is stored in a memory area called the refresh buffer or frame buffer





A raster-scan system displays an object as a set of discrete points across each scan line.



- https://www.youtube.com/watch?v=dlT-seESkj0

Raster scan advantage and disadvantages

- **Advantages**:

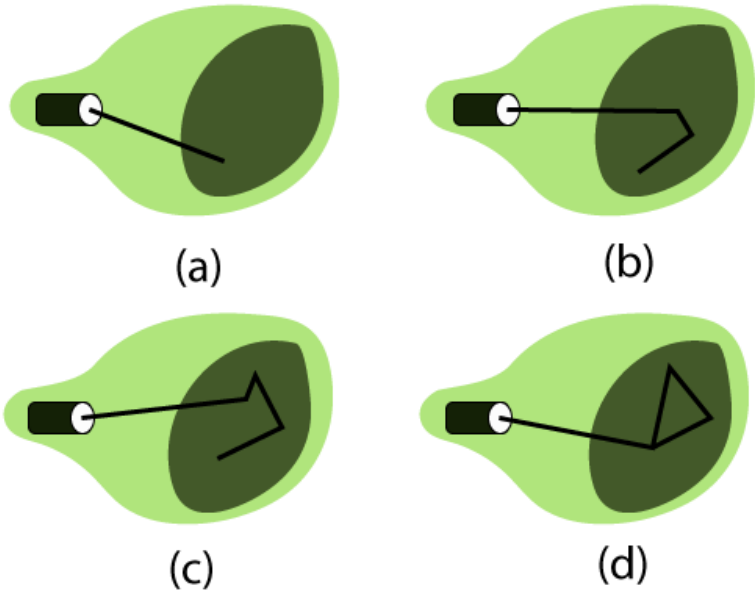
1. Realistic image
2. Million Different colors to be generated
3. Shadow Scenes are possible.

- **Disadvantages**:

1. Low Resolution
2. Expensive

B)Random – Scan Systems

In this technique, the electron beam is directed only to the part of the screen where the picture is to be drawn rather than scanning from left to right and top to bottom as in raster scan. It is also called **vector display, stroke-writing display,** or **calligraphic display**.



Random scan advantage and disadvantage

- **Advantages:**

1. A CRT has the electron beam directed only to the parts of the screen where an image is to be drawn.
2. Produce smooth line drawings.
3. High Resolution

- **Disadvantage:**

1. Random-Scan monitors cannot display realistic shades scenes.

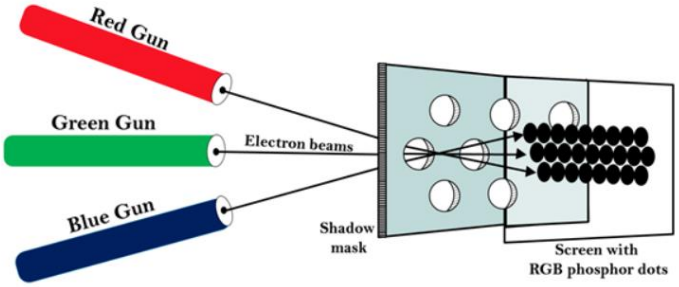
2. More expensive

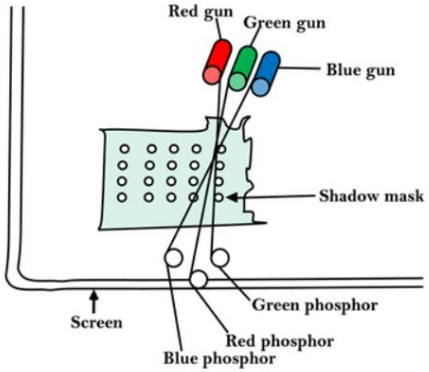
Differentiate between Random and Raster Scan Display:

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~~ on 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.

2)Color CRT Monitors

- **Use RGB color model**
- **Produce more colors**
- **Each pixel composed of three phosphor color dots (RGB)**
- **3 electronic guns are used**

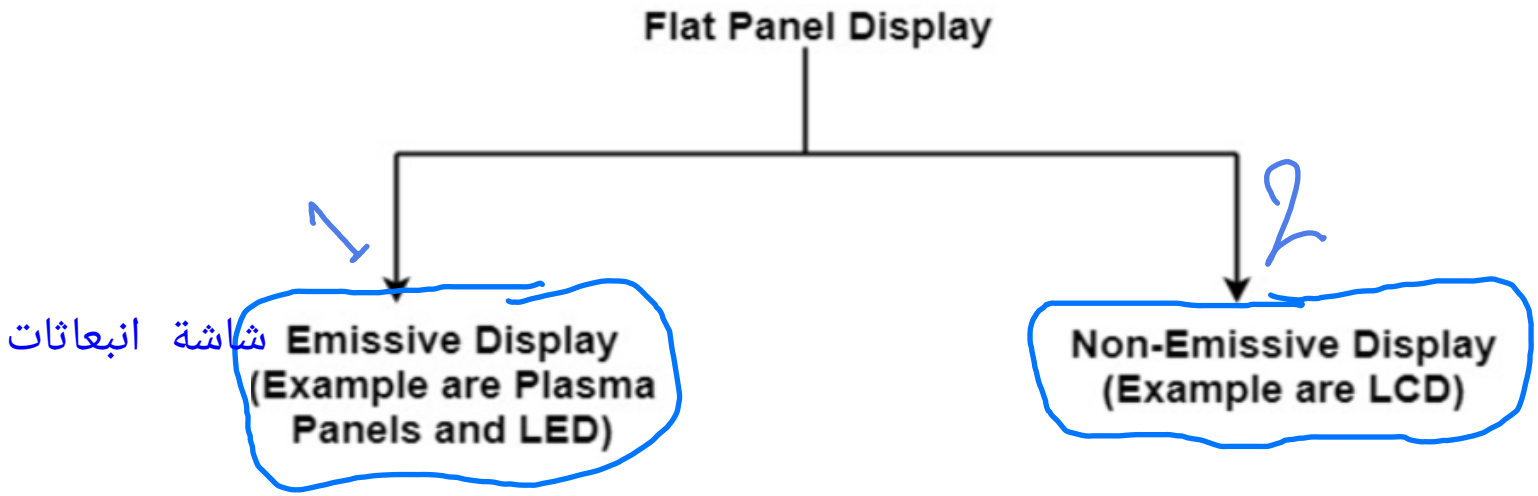




Flat-Panel displays

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.



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3)Liquid Crystal Display LCD

Produce pictures by passing polarized light through liquid crystal material that can be aligned to either block or transmit the light

Advantages:

- Produce a bright image
- Energy efficient
- Completely flat screen

Disadvantages:

- Fixed aspect ratio & Resolution
- Lower Contrast التباين الأدنى
- More Expensive

4)Light Emitting Diode (LED):

LED is a device which emits when current passes through it. It is a semiconductor device.
The size of the LED is small, so we can easily make any display unit by arranging a large number of LEDs.
LED consumes more power compared to LCD. LED is used on TV, smartphones, motor vehicles, traffic light, etc.
LEDs are powerful in structure, so they are capable of withstanding mechanical pressure. LED also works at high temperatures.

Advantages:

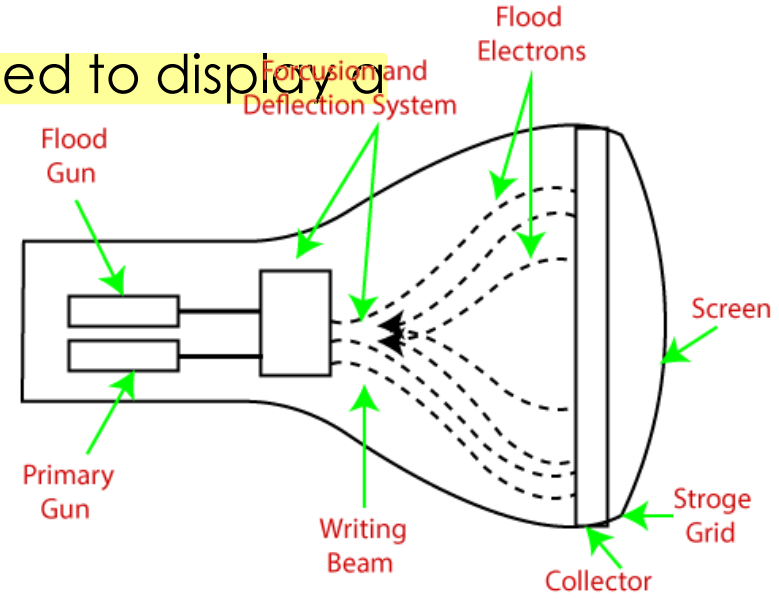
The Intensity of light can be controlled.
Low operational Voltage.
Capable of handling the high temperature.

Disadvantages:

More Power Consuming than LCD

5)Direct View Storage Tube (DVST):

- It is used to store the picture information as a charge distribution behind the phosphor-coated screen.
- There are two guns used in DVST:
- **1.Primary Gun:** It is used to store the picture information.
- **2.Flood / Secondary Gun:** It is used to display a picture on the screen.



6) 3D Display:

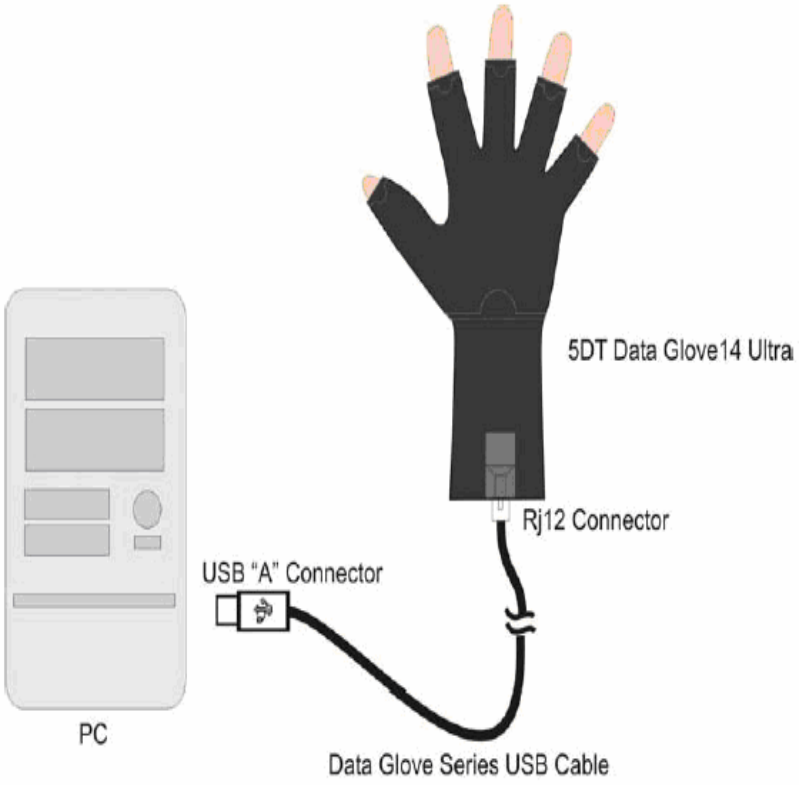
It is also called **stereoscope display** technology. This technology is capable of bringing depth perception to the viewer.

- It is used for 3D gaming and 3D TVs.
- **For Example:** Fog Display, Holographic Display, Retina Display Etc.
- **Advantages:**
- Impressive Picture Quality
- High Definition
- **Disadvantage:**
- Expensive
- Binocular Fusion

Input and Hard Copy Devices

Input Devices

- Keyboard and mouser
- Trackball
- Joysticks
- Data glove
- Voice system
- early light pens to modern mice
- data tablet
- touch sensitive screens
- 3D input devices (space balls etc.)
- button and dial boxes



Output Devices

- Printers
- Pen plotter

Output Device

- **Raster Devices**

CRT - the common display device for personal computers.

LCD - A smaller, lighter, lower power replacement for the CRT.

LED - A smaller, lighter, lower power replacement for the CRT.

Plasma screens - a more expensive but brighter alternative to LCDs.

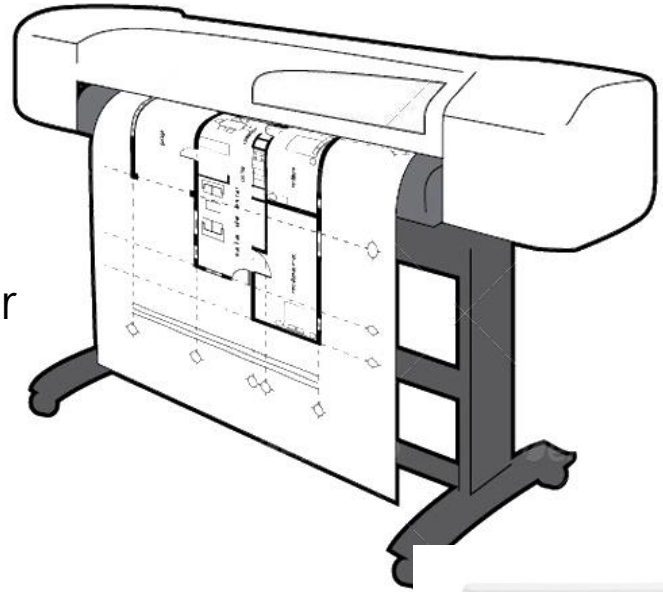
Printers - today's printers are good for both text and graphics

- **Vector Devices**

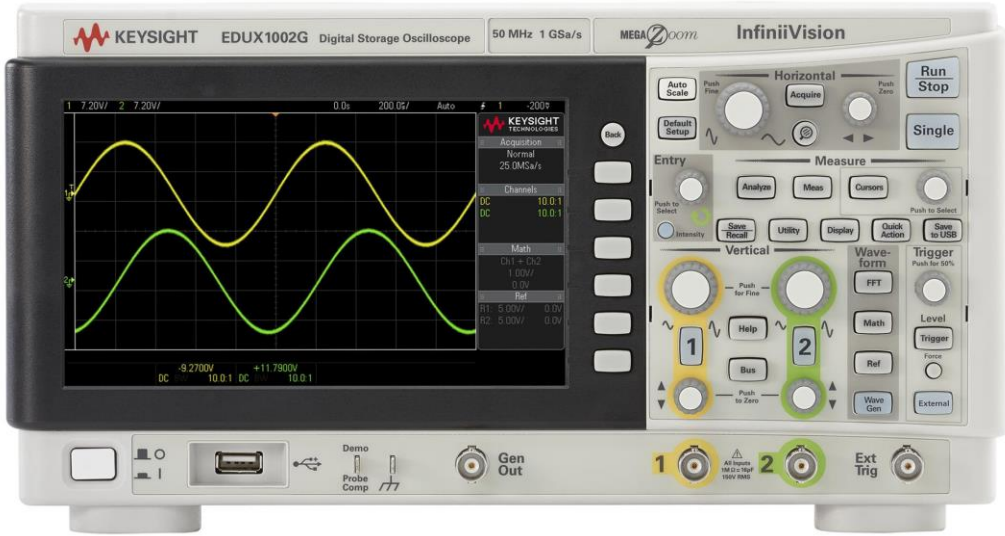
Plotters - good for vector graphics.

Oscilloscope - an early vector graphics output device

Plotter



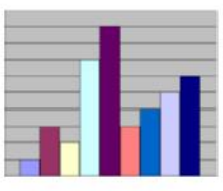
Oscilloscope



Application of Computer Graphics

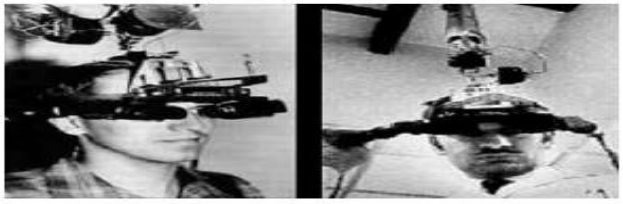
- Computer graphics user interfaces (GUIs)
- Business presentation graphics
- Cartography
- Weather Maps
- Satellite Imaging
- Photo Enhancement
- Medical imaging Engineering drawings
- Typography
- Architecture
- Art
- Training
- Entertainment
- Simulation and modeling

Application of Computer Graphics



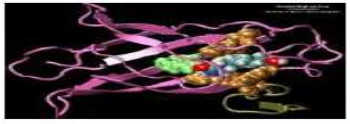
- **Graphs and Charts**
- used to produce illustrations for reports

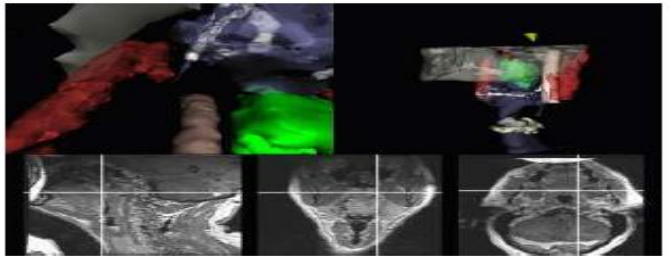
- **Computer Aided Design CAD**
- used in the design of buildings, automobiles, aircraft, watercraft, spacecraft, computers …



- **Virtual-Reality Environments**
- a user can interact with the object in 3D scene

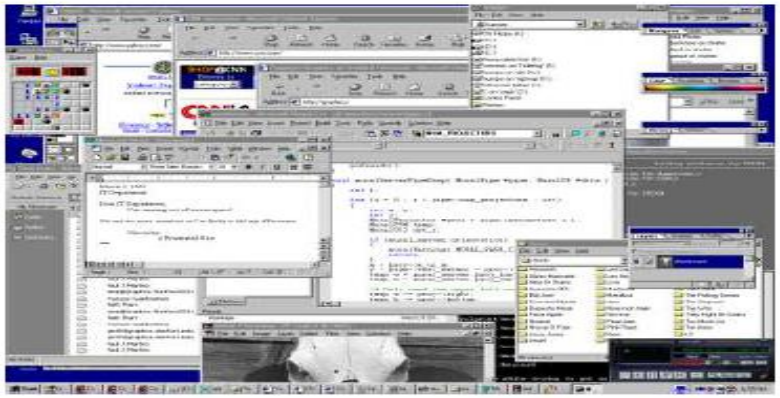
- **Data Visualization**
- used to produce graphical representations for scientific, engineering, and medical datasets and processes





- **Entertainment**
- used in making motion pictures, music videos, and television shows

- **Graphical User Interfaces GUI**
- A major component of a graphical interface is a window manager that allows a user to display multiple-window areas



- Advertisement

- Games

Review Questions and Discussion

1. What do you mean by rasterization?
2. Compare raster and vector scan displays.
3. Write a short note on
   a. 3D Display
   b. Plasma panel display
4. What do you understand by the terms raster scan and refresh rate?

Reading List

- *"Computer Graphics with OpenGL" , chapter 1, 2.*
- *http://www.sketchpad.net/basics1.htm*
- *https://www.tutorialspoint.com/computer_graphics/computer_graphics_basics.htm*
- *https://www.javatpoint.com/interactive-and-passive-graphics*