CSE-303: COMPUTER GRAPHICS

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BOOKS

Textbook:

- Angel and Shreiner: Interactive Computer Graphics 6E © Addison-Wesley 2012

Reference Book:

- Roy A. Plastock and Zhigang Xiang : Computer Graphics 2/E Book © Schaum's Outline Series

OBJECTIVES

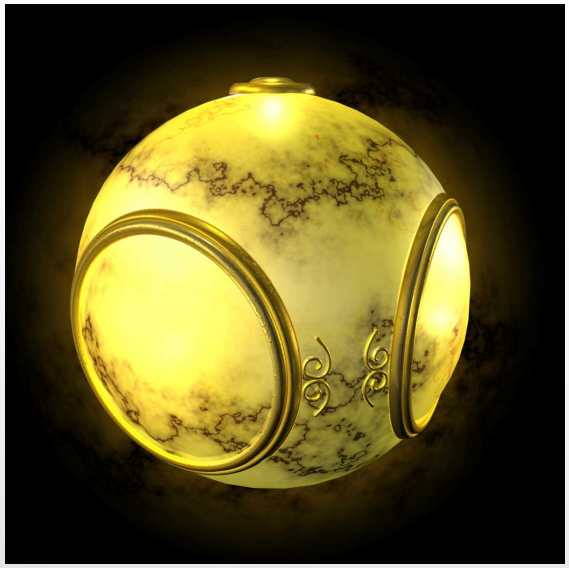
- In this lecture, we explore what computer graphics is about and survey some application areas
- We start with a historical introduction

COMPUTER GRAPHICS

- *Computer graphics* deals with all aspects of creating images with a computer
  - Hardware
  - Software
  - Applications

EXAMPLE

- Where did this image come from?



- What hardware/software did we need to produce it?

PRELIMINARY ANSWER

- **Application**: the object is an artist's rendition of the sun for an animation to be shown in a domed environment (planetarium)
- **Software**: maya for modeling and rendering but maya is built on top of OpenGL
- **Hardware**: PC with graphics card for modeling and rendering

APPLICATION AREAS

- Computer art:
  - Create fine and commercial art: animation packages, paint packages
  - Packages provide facilities for designing object shapes and specifying object motion
  - Cartoon drawing, paintings, logo design can also be done
- Computer aided drawing:
  - Designing of buildings, automobile, aircraft
  - Provides minute details to the drawing and producing more accurate and sharp drawings with better specifications
- Presentation graphics:
  - Preparation of reports or summarising the financial, statistical, mathematical, scientific, economic data for research reports, managerial reports, moreover creation of bar graphs, pie charts, time chart
- Entertainment:
  - Movie industry and game industry
  - Used for creating motion pictures , music video, television shows, cartoon animation films

APPLICATION AREAS…

- Education:

Computer generated models are extremely useful for teaching huge number of concepts and fundamentals in an easy to understand and learn manner. Using computer graphics many educational models can be created through which more interest can be generated among the students regarding the subject.

- Training:

Specialised system for training like simulators can be used for training the candidates in a way that can be grasped in a short span of time with better understanding. Creation of training modules using computer graphics is simple and very useful.

- Visualisation:

Today the need of visualise things have increased drastically, the need of visualisation can be seen in many advance technologies , data visualisation helps in finding insights of the data , to check and study the behaviour of processes around us we need appropriate visualisation which can be achieved through proper usage of computer graphics

APPLICATION AREAS…

- Image processing:

Various kinds of photographs or images require editing in order to be used in different places. Processing of existing images into refined ones for better interpretation is one of the many applications of computer graphics.

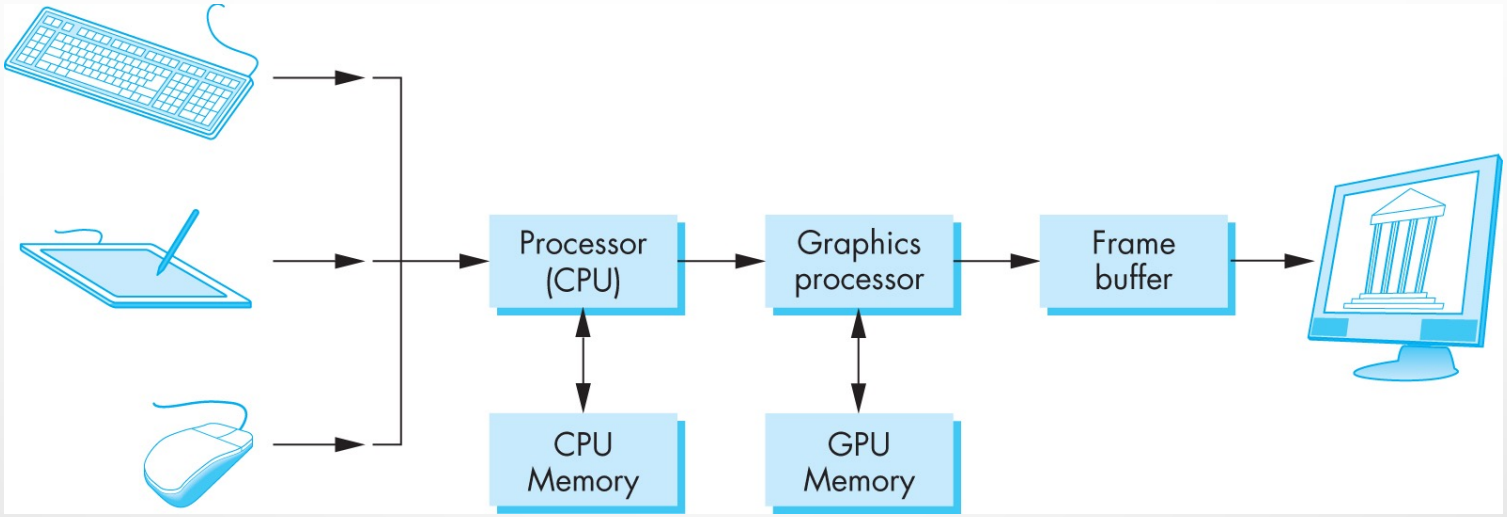
- Machine drawing:

Computer graphics is very frequently used for designing, modifying and creation of various parts of machine and the whole machine itself, the main reason behind using computer graphics for this purpose is the precision and clarity we get from such drawing is ultimate and extremely desired for the safe manufacturing of machine using these drawings.

- Graphical user interface:

The use of pictures, images, icons, pop-up menus, graphical objects helps in creating a user friendly environment where working is easy and pleasant, using computer graphics we can create such an atmosphere where everything can be automated and anyone can get the desired action performed in an easy fashion.

BASIC GRAPHICS SYSTEM

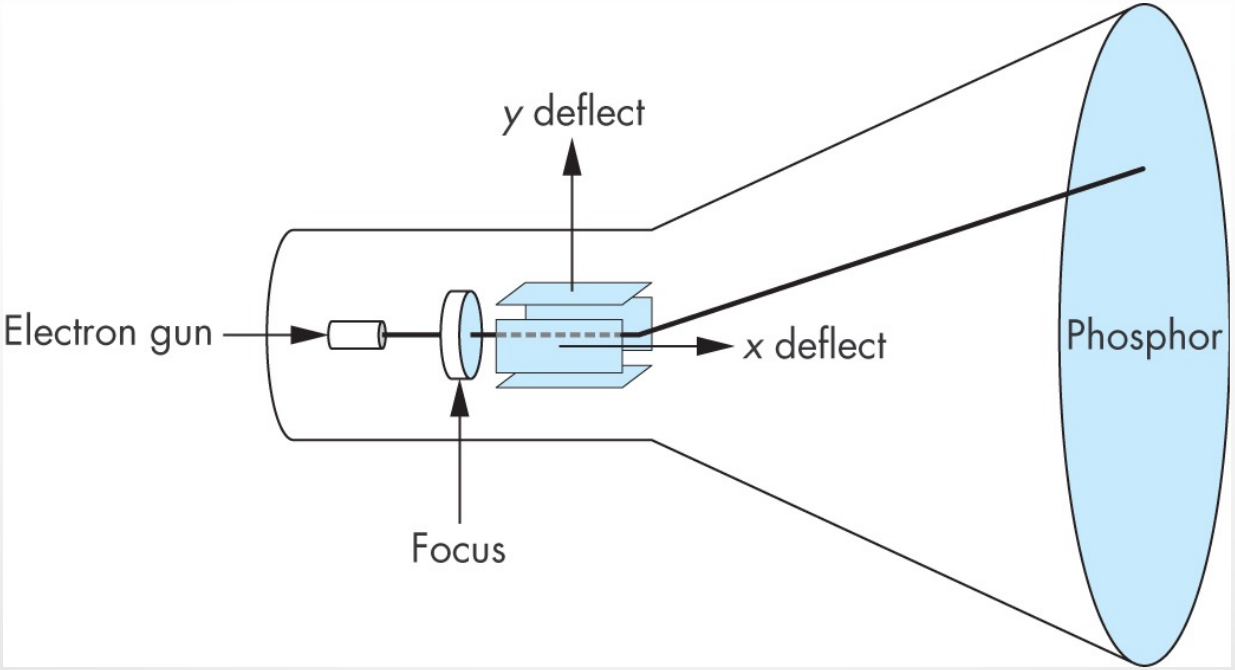


Input devices

Output device

Image formed in frame buffer

CRT



Can be used either as a line-drawing device (calligraphic) or to display contents of frame buffer (raster mode)

HOW CRT WORKS?

The operation of CRT is very simple −

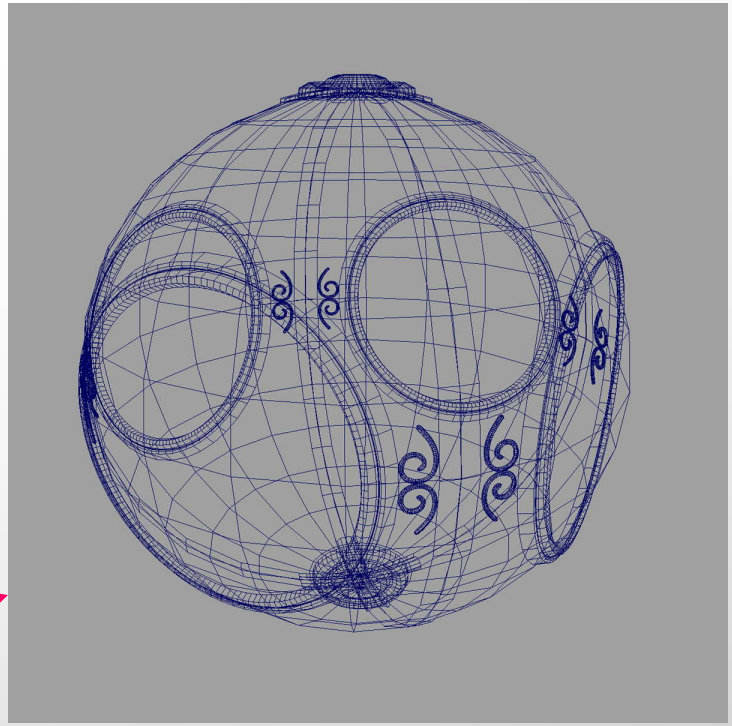
- The electron gun emits a beam of electrons *cathode rays*.
- The electron beam passes through focusing and deflection systems that direct it towards specified positions on the phosphor-coated screen.
- When the beam hits the screen, the phosphor emits a small spot of light at each position contacted by the electron beam.
- It redraws the picture by directing the electron beam back over the same screen points quickly.

COMPUTER GRAPHICS: 1950-1960

- Computer graphics goes back to the earliest days of computing
  - Strip charts
  - Pen plotters
  - Simple displays using A/D converters to go from computer to calligraphic CRT
- Cost of refresh for CRT too high
  - Computers slow, expensive, unreliable

COMPUTER GRAPHICS: 1960-1970

- *Wireframe* graphics
  - Draw only lines
- Sketchpad
- Display processors
- Storage tube



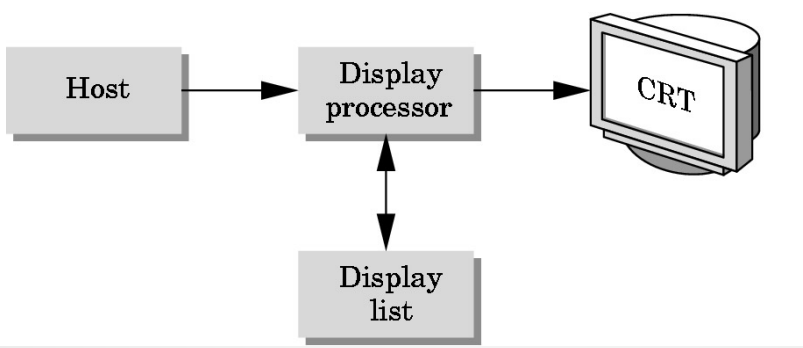
wireframe representation
of sun object

SKETCHPAD

- Ivan Sutherland's PhD thesis at MIT
  - Recognized the potential of man-machine interaction
  - Loop
    - Display something
    - User moves light pen
    - Computer generates new display
  - Sutherland also created many of the now common algorithms for computer graphics

DISPLAY PROCESSOR

- Rather than have the host computer try to refresh display use a special purpose computer called a *display processor* (DPU)



- Graphics stored in display list (display file) on display processor
- Host *compiles* display list and sends to DPU

DIRECT VIEW STORAGE TUBE

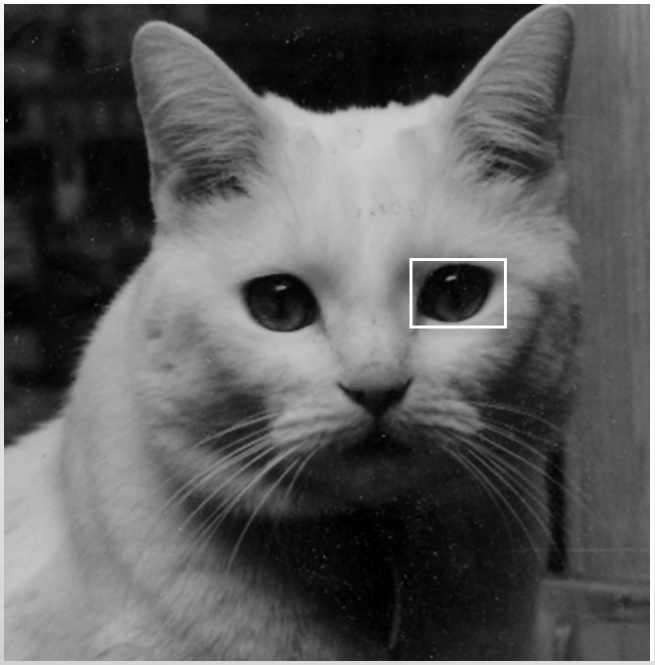
- Created by Tektronix
  - Did not require constant refresh
  - Standard interface to computers
    - Allowed for standard software
    - Plot3d in Fortran
  - Relatively inexpensive
    - Opened door to use of computer graphics for CAD community

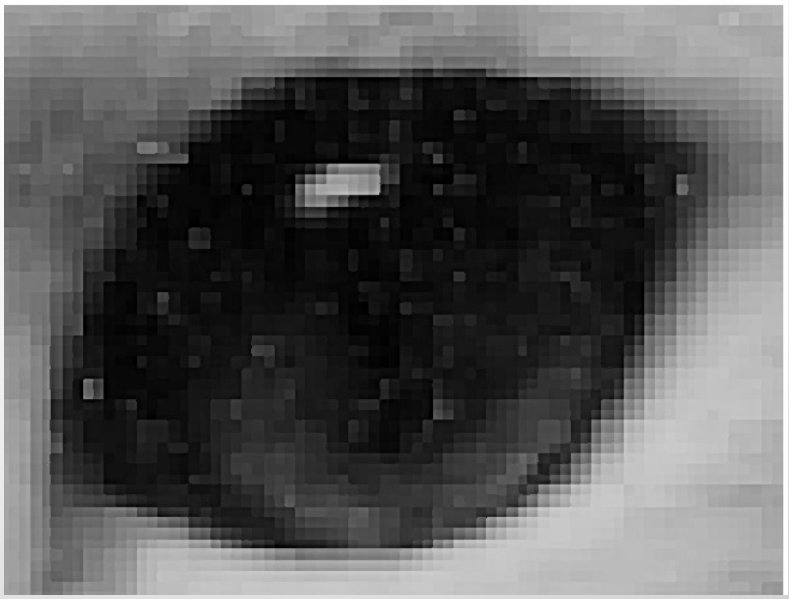
COMPUTER GRAPHICS: 1970-1980

- Raster graphics
- Beginning of graphics standards
  - IFIPS
    - GKS: European effort
      - Becomes ISO 2D standard
    - Core: North American effort
      - 3D but fails to become ISO standard
- Workstations and pcs

RASTER GRAPHICS

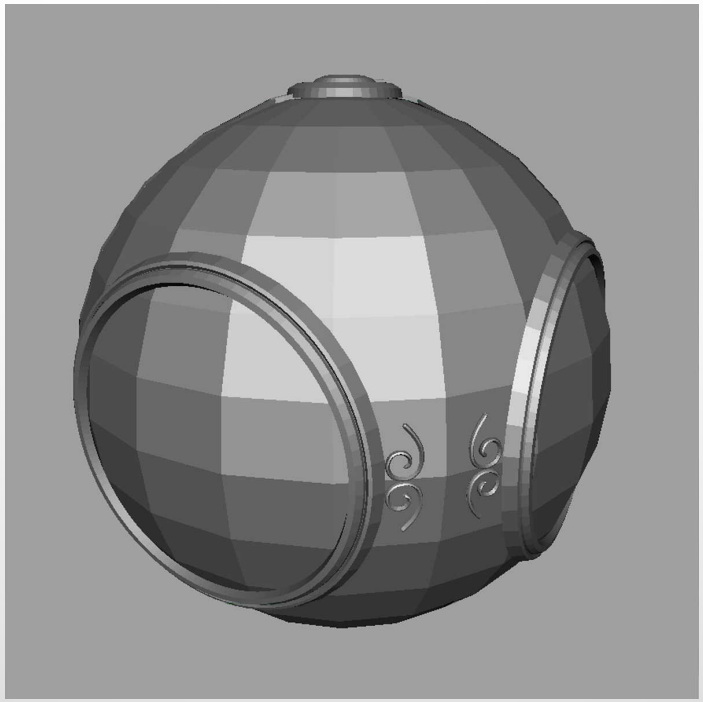
- Image produced as an array (the *raster*) of picture elements (*pixels*) in the *frame buffer*



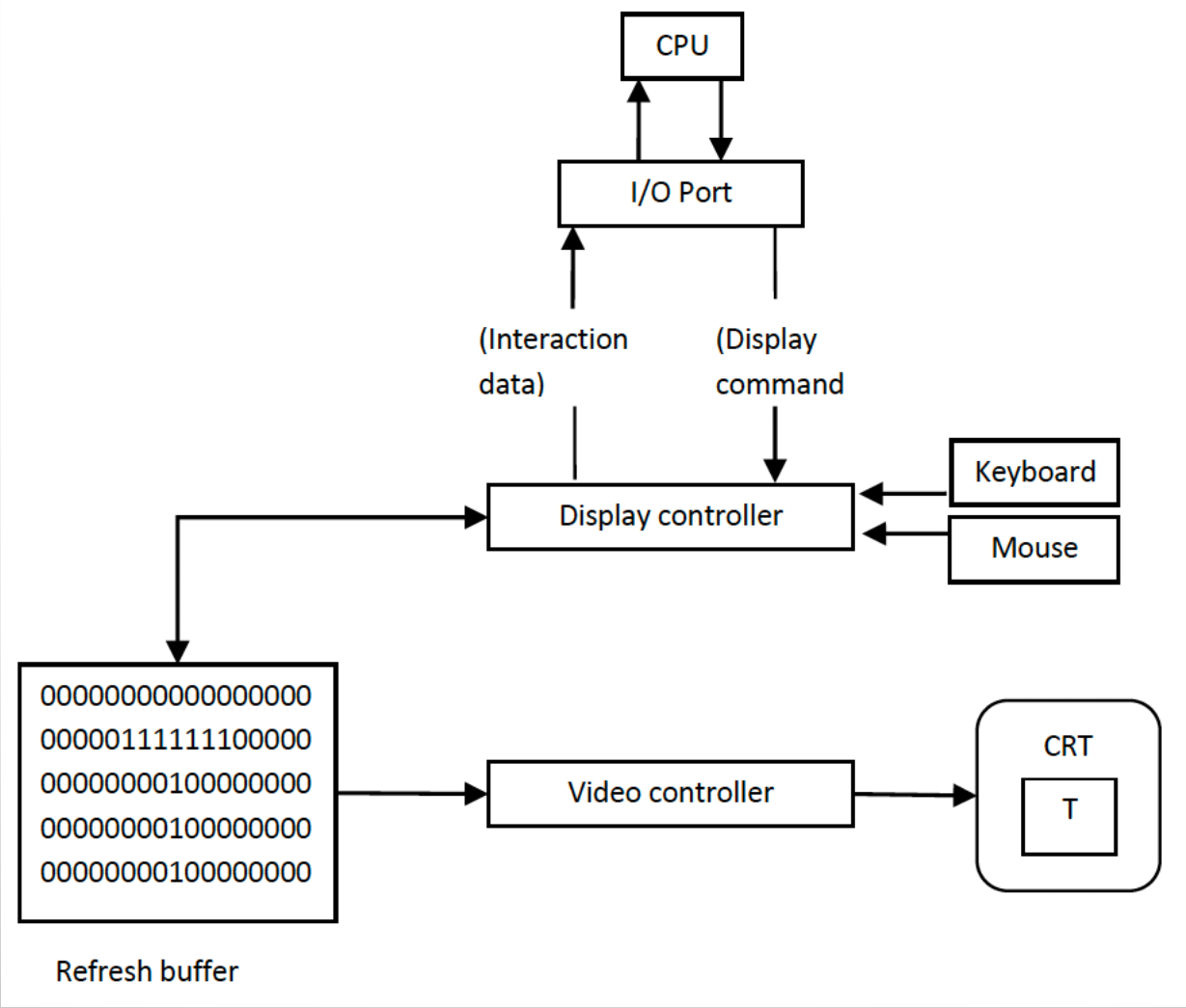


RASTER GRAPHICS

- Allows us to go from lines and wire frame images to filled polygons



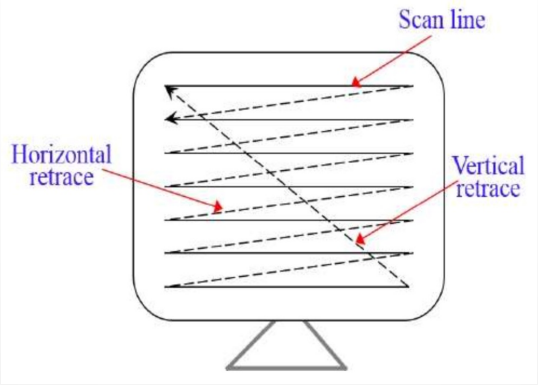
RASTER SCAN



Architecture of a raster display

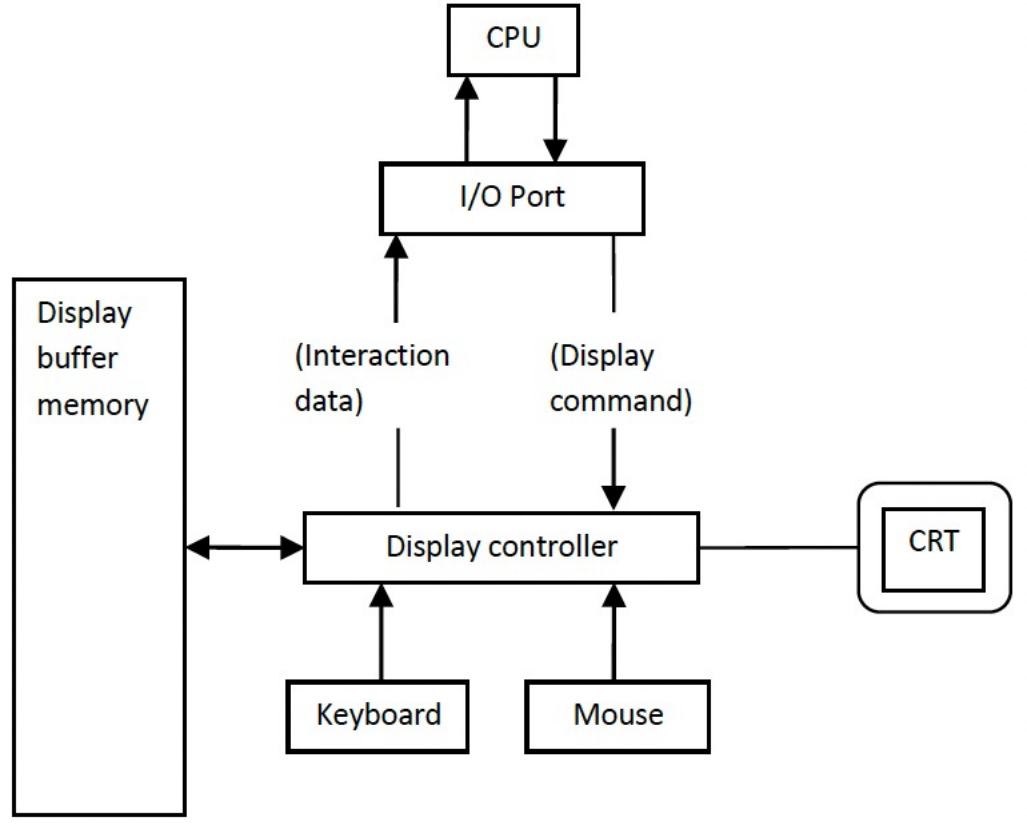
RASTER SCAN

- In a raster scan system, the electron beam is swept across the screen, one row at a time from top to bottom. As the electron beam moves across each row, the beam intensity is turned on and off to create a pattern of illuminated spots.



- Picture definition is stored in memory area called the **refresh buffer** or **frame buffer**. This memory area holds the set of intensity values for all the screen points. Stored intensity values are then retrieved from the refresh buffer and "painted" on the screen one row scanline at a time as shown in the following illustration.
- Each screen point is referred to as a **pixel** picture element or **pel**. At the end of each scan line, the electron beam returns to the left side of the screen to begin displaying the next scan line.

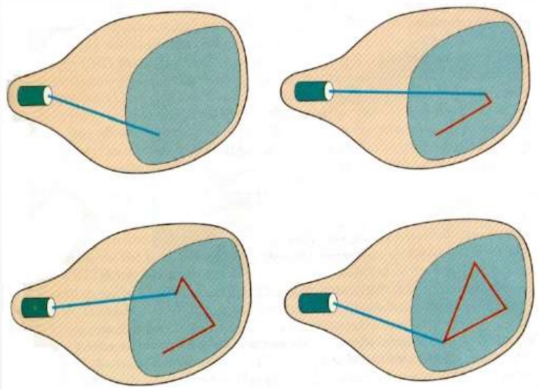
VECTOR SCAN



Architecture of a vector display

VECTOR SCAN

- 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**.



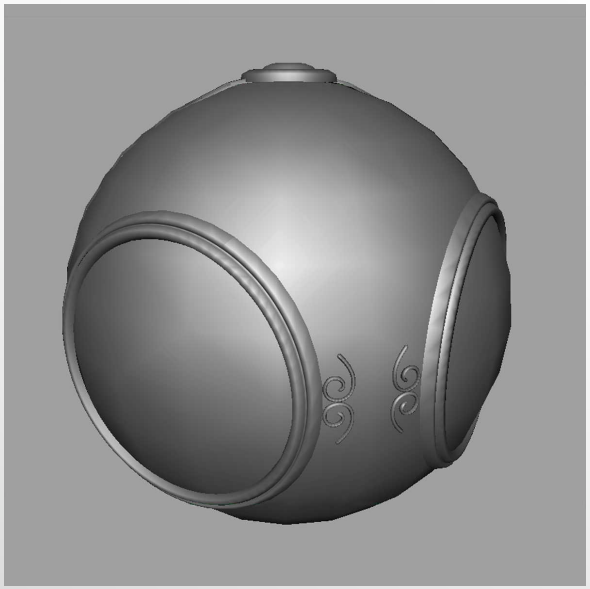
- Picture definition is stored as a set of line-drawing commands in an area of memory referred to as the **refresh display file**. To display a specified picture, the system cycles through the set of commands in the display file, drawing each component line in turn. After all the line-drawing commands are processed, the system cycles back to the first line command in the list.
- Random-scan displays are designed to draw all the component lines of a picture 30 to 60 times each second.

PCS AND WORKSTATIONS

- Although we no longer make the distinction between workstations and pcs, historically they evolved from different roots
  - Early workstations characterized by
    - Networked connection: client-server model
    - High-level of interactivity
  - Early pcs included frame buffer as part of user memory
    - Easy to change contents and create images

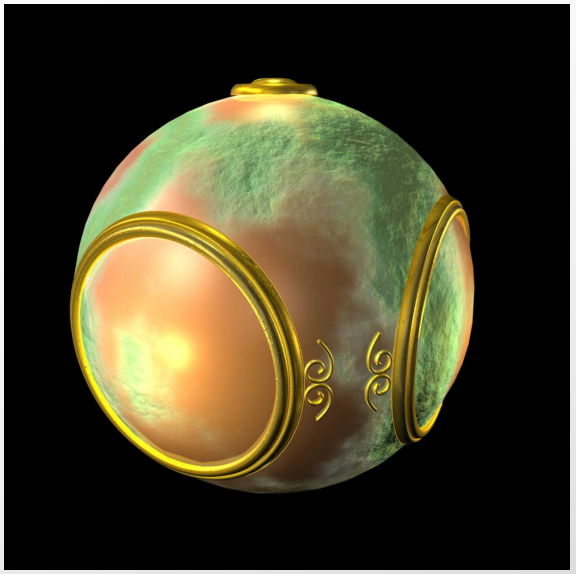
COMPUTER GRAPHICS: 1980-1990

Realism comes to computer graphics



smooth shading

environment mapping



bump mapping

COMPUTER GRAPHICS: 1980-1990

- Special purpose hardware
  - Silicon graphics geometry engine
    - VLSI implementation of graphics pipeline
- Industry-based standards
  - PHIGS
  - RENDERMAN
- Networked graphics: X window system
- Human-computer interface (HCI)

COMPUTER GRAPHICS: 1990-2000

- OpenGL API
- Completely computer-generated feature-length movies (toy story) are successful
- New hardware capabilities
  - Texture mapping
  - Blending
  - Accumulation, stencil buffers

COMPUTER GRAPHICS: 2000-

- Photorealism
- Graphics cards for pcs dominate market
  - Nvidia, ATI
- Game boxes and game players determine direction of market
- Computer graphics routine in movie industry: maya, lightwave
- Programmable pipelines

ASSIGNMENT

OLED

Architecture?

How it Works?