

**Faculty of German Engineering and
Industrial Management Education - FDIBA**

Introduction to Computer Graphics



Graphics Devices

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Graphics Devices

- Principles and Constraints

- Hardware

- Standard

- Graphics Devices

- Output

- Display
 - Printer
 - Plotter

- Input

- Various Types

Standard Hardware

- Typical Features

- Moore's Law

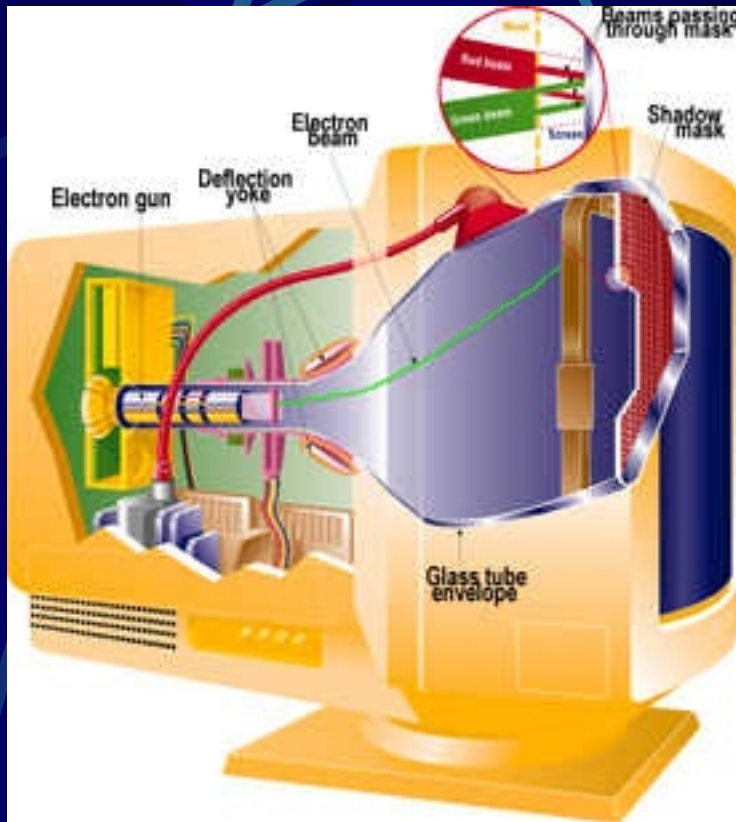
- price/performance improves 2x every 18 months due to doubling of number of transistors
- only exponential in technology except for growth of WWW

For more Information...

RAM: 256 - 512 MB, CPU: Pentium , AMD: 12000 – 3200 MHz
HDD: 20 -200 GB, Display: 1600/1200/true color

Display Technologies

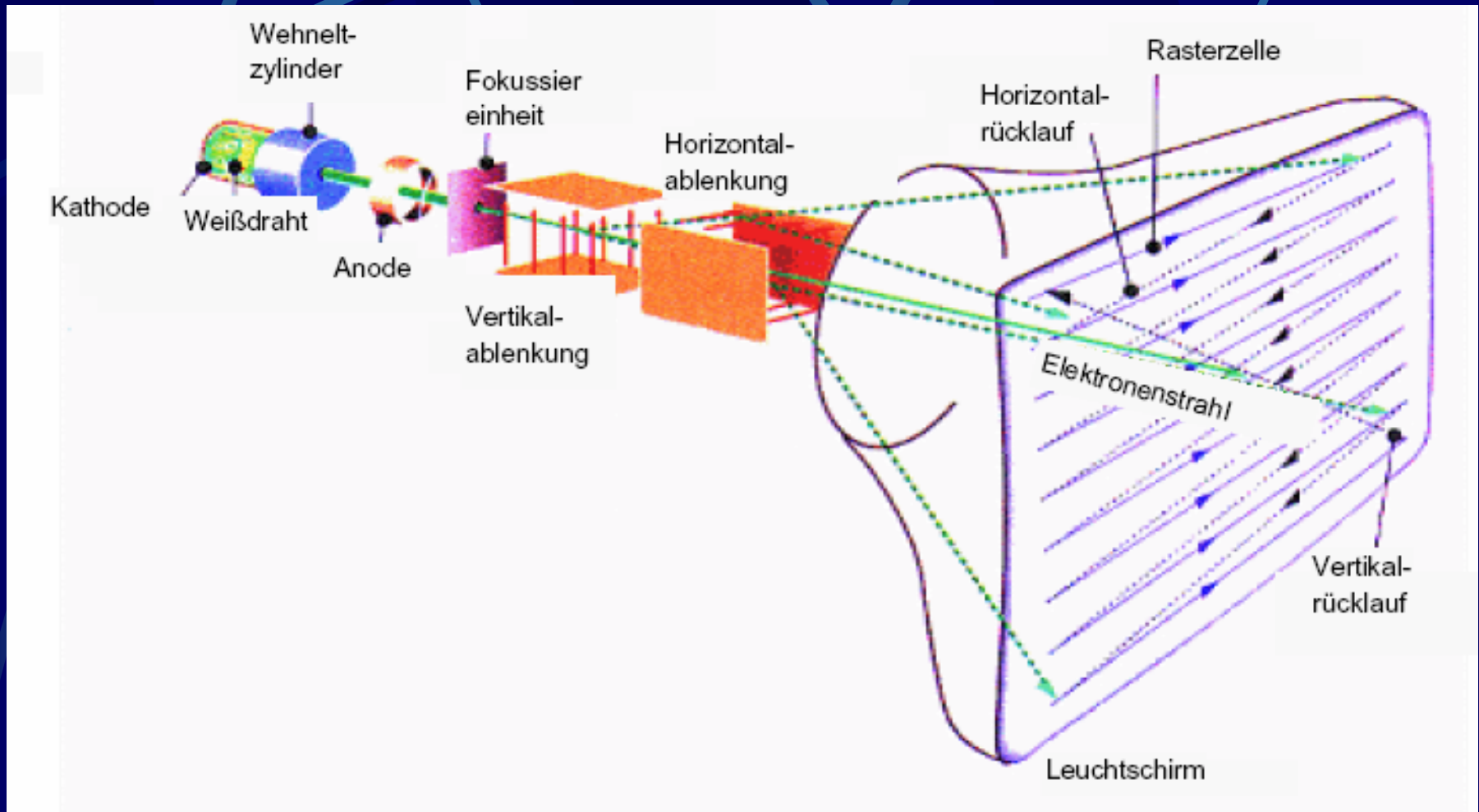
Cathode Ray Tubes (CRTs)



- Most common display device today
- Evacuated glass bottle (last remaining vacuum tube)
- Heating element (filament)
- Electrons attracted to focusing anode cylinder
- Vertical and Horizontal deflection plates
- Beam strikes phosphor coating on front of tube

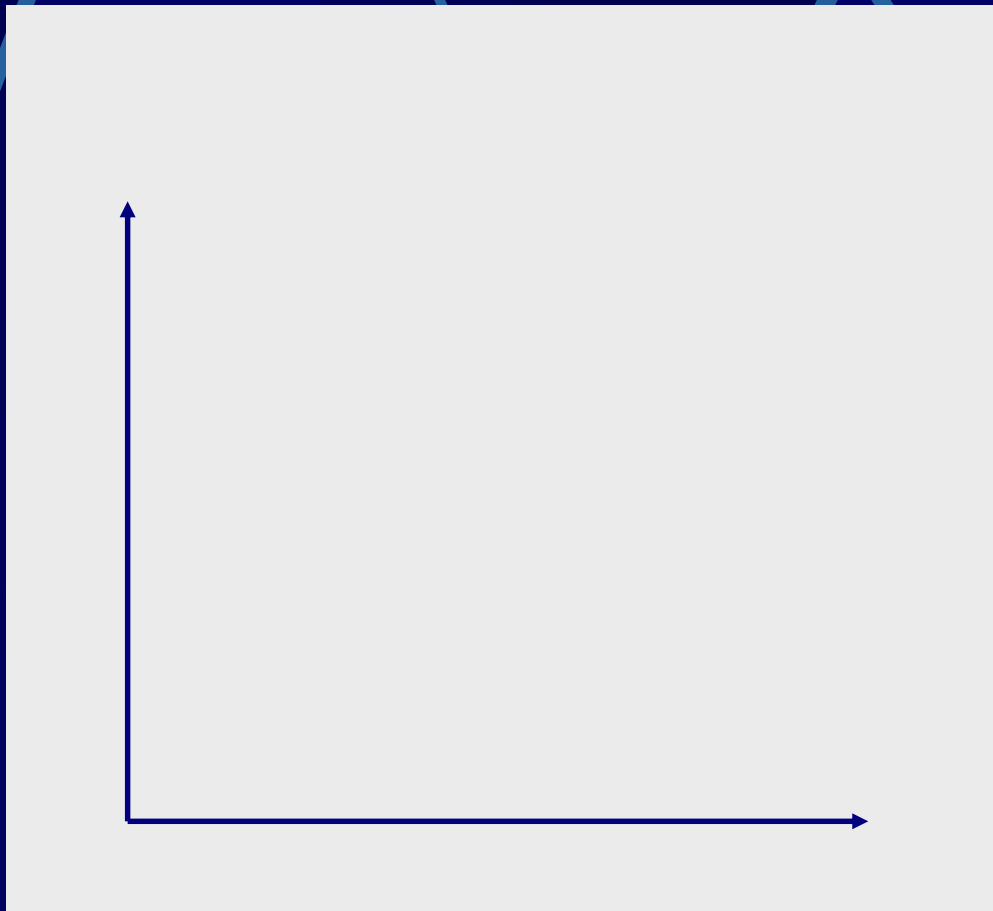
Display – Basic principle

Cathode Ray Tube (CRT)



Display Technologies

- What happens when the beam moves to another point of the display surface?



Display Technologies

- Display list had to be constantly updated (except for storage tubes)
 - Storage Display
 - Refresh Display

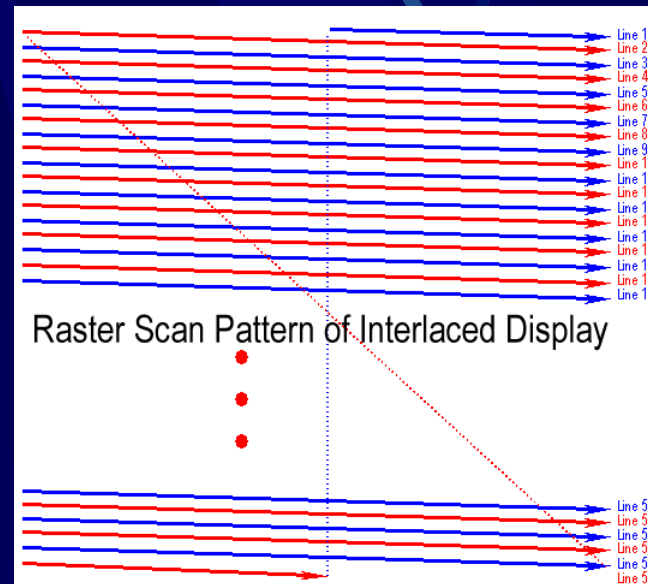
Graphics Devices

● 2 Types of Displays:

- Vector

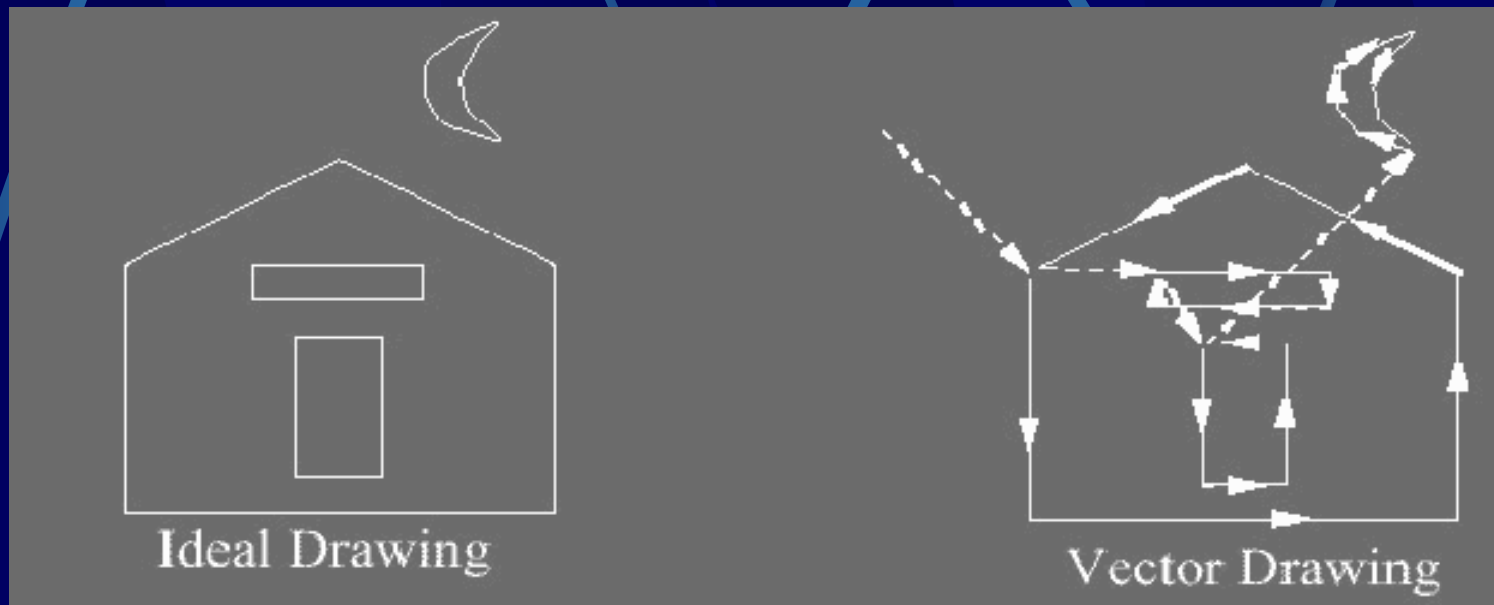


- Raster



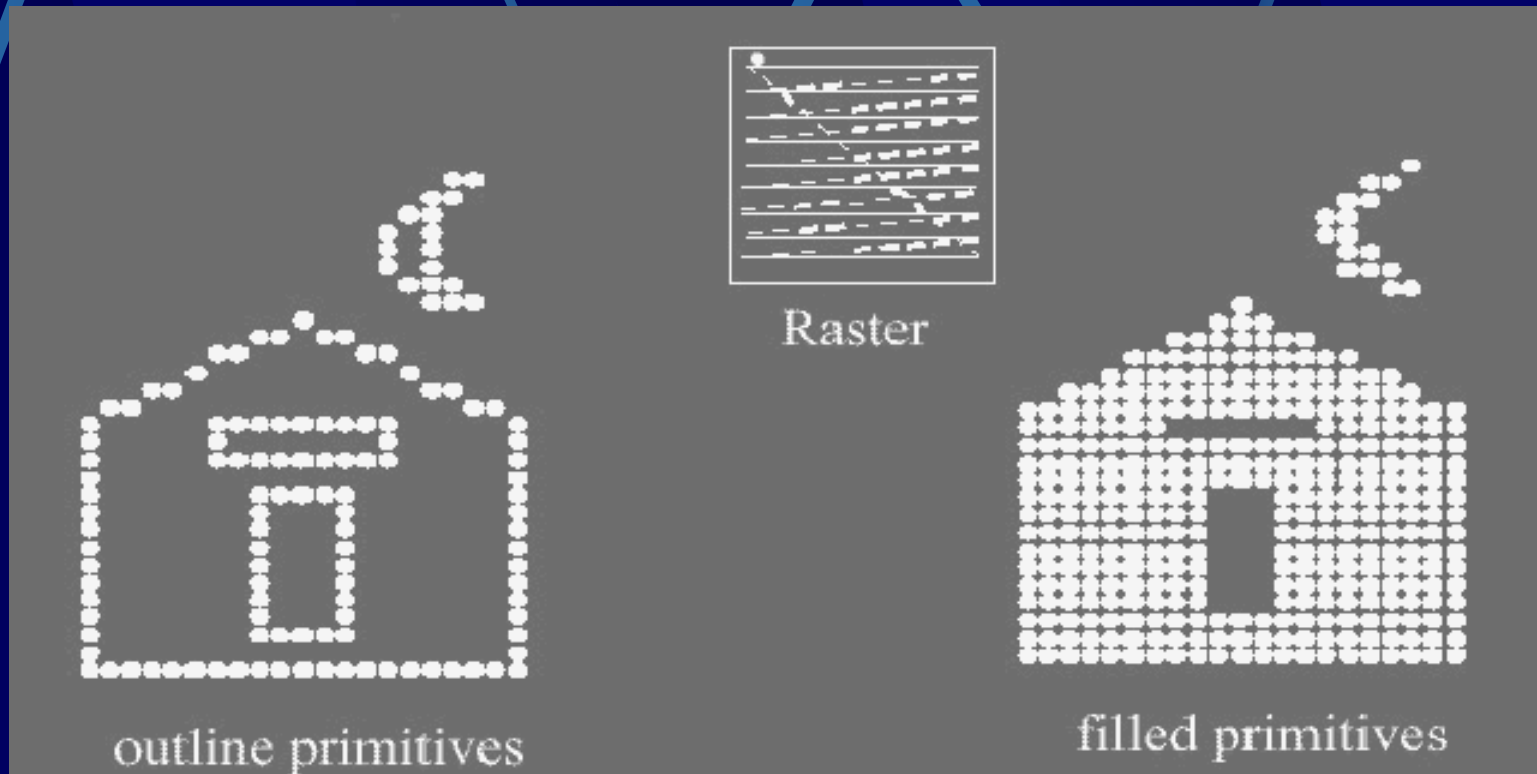
Vector Display

- How the Image is generated



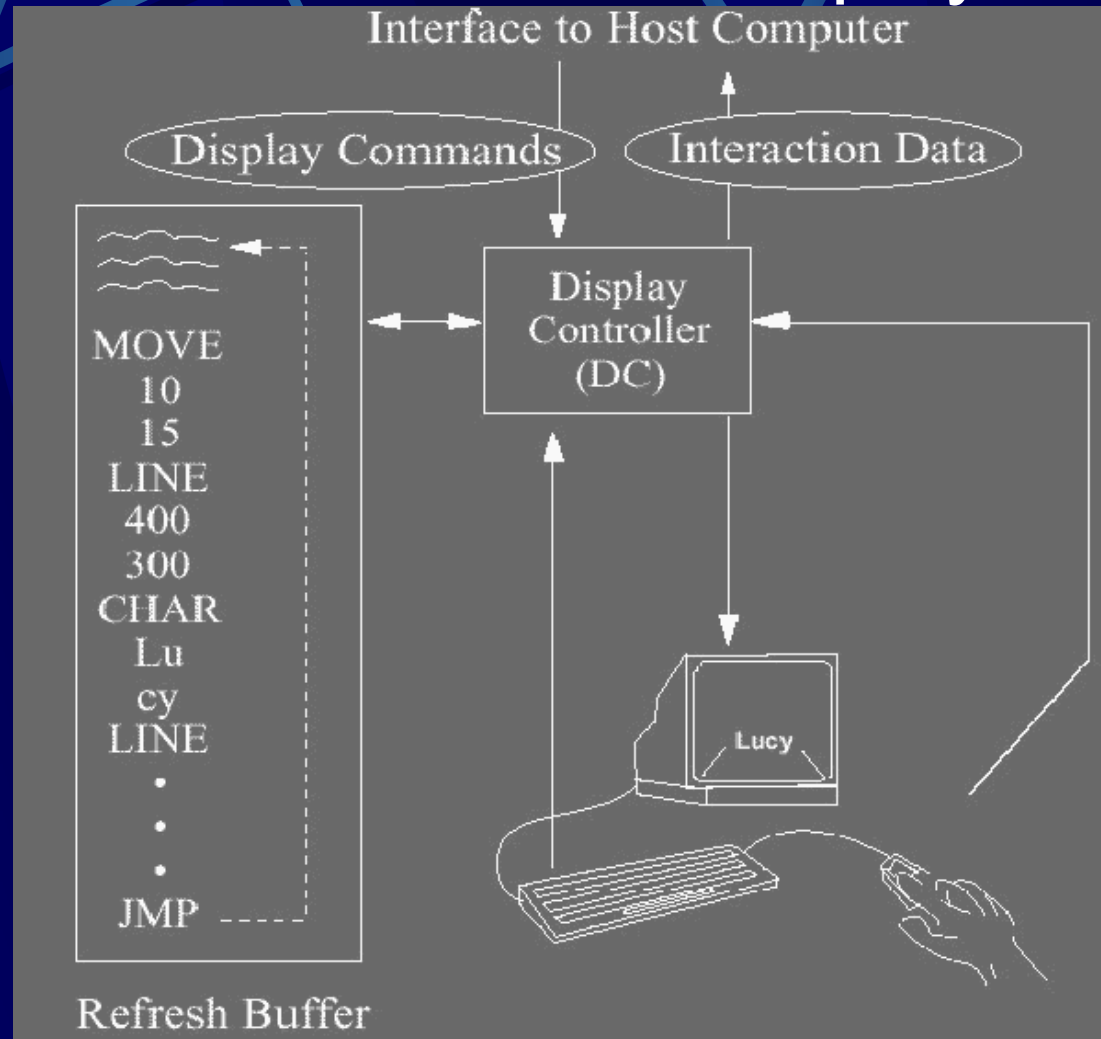
Raster Display

- How the Image is generated



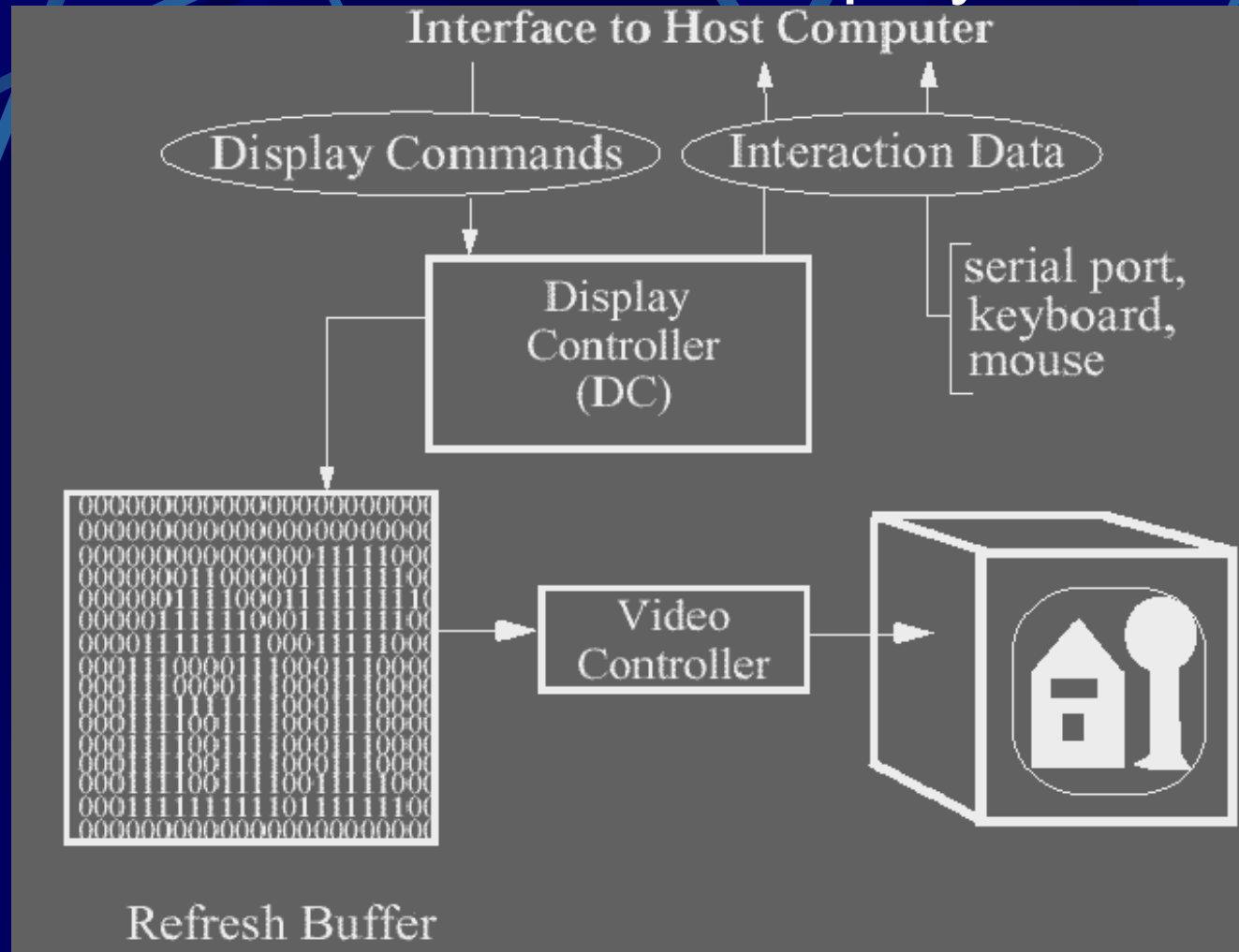
Vector Display

● Architecture of Vector Display



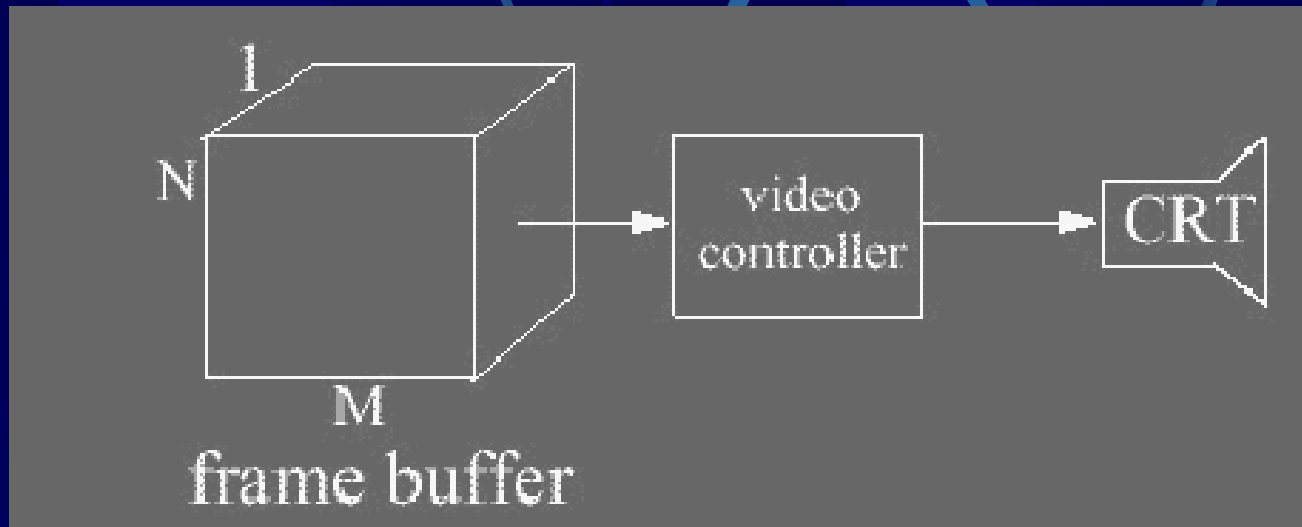
Raster Display

● Architecture of Raster Display



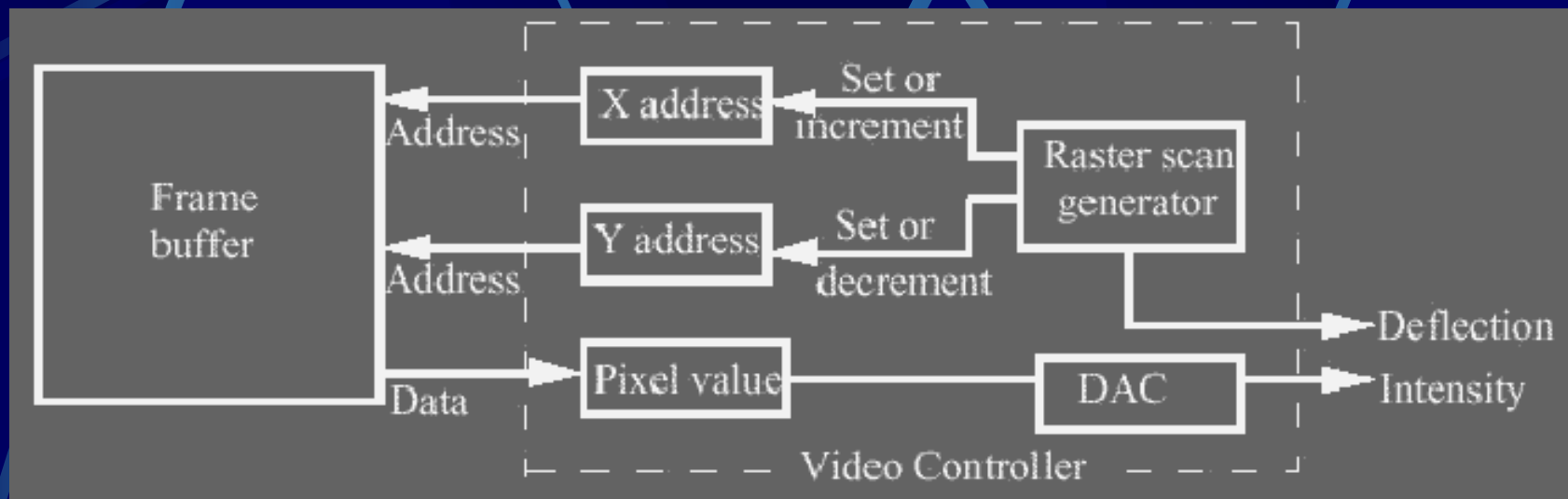
Raster Display

- Frame buffer
- Monochrome Display
 - Frame Buffer $M * N$



Raster Display

● Architecture



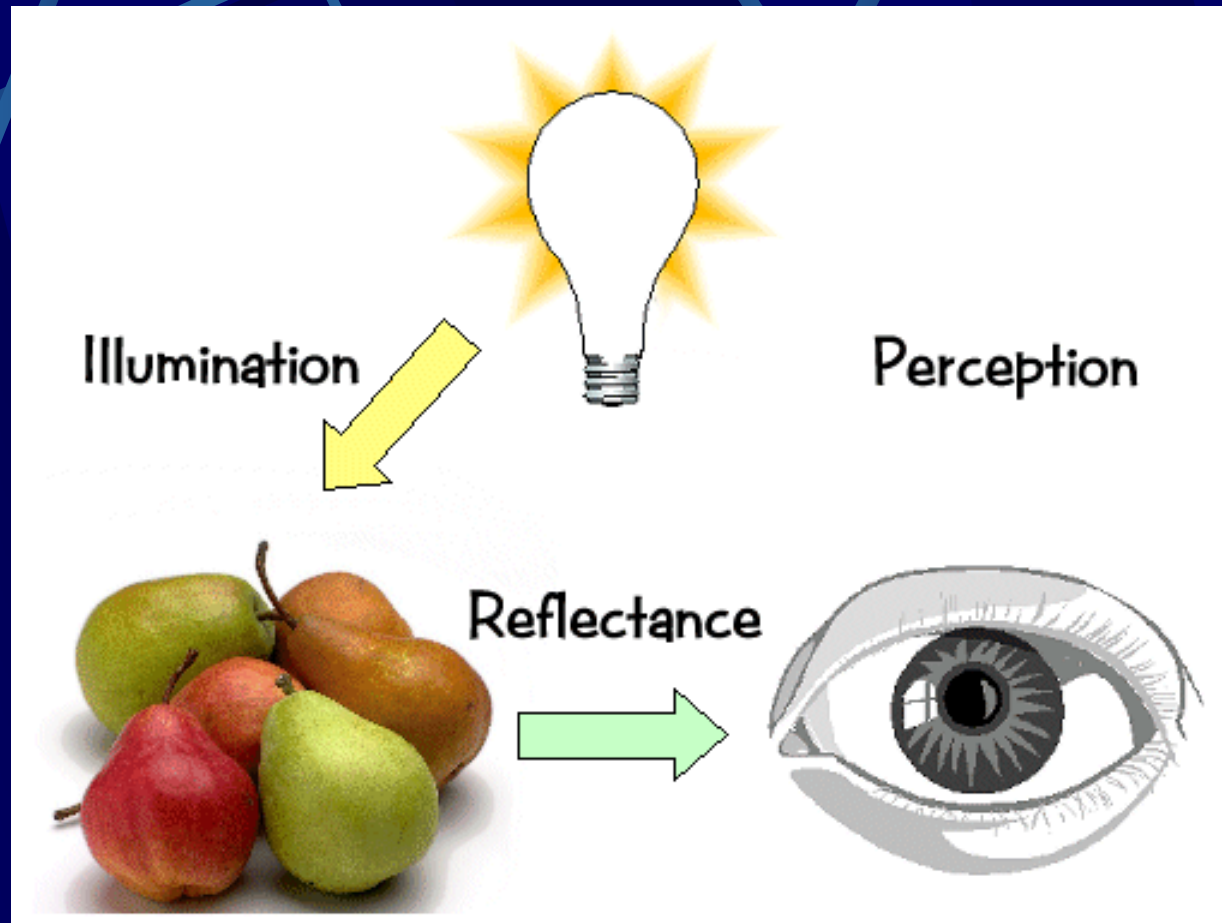
For more Information...

DAC – Digital to Analog Converter – controls the intensity of the electron beam

Raster Display

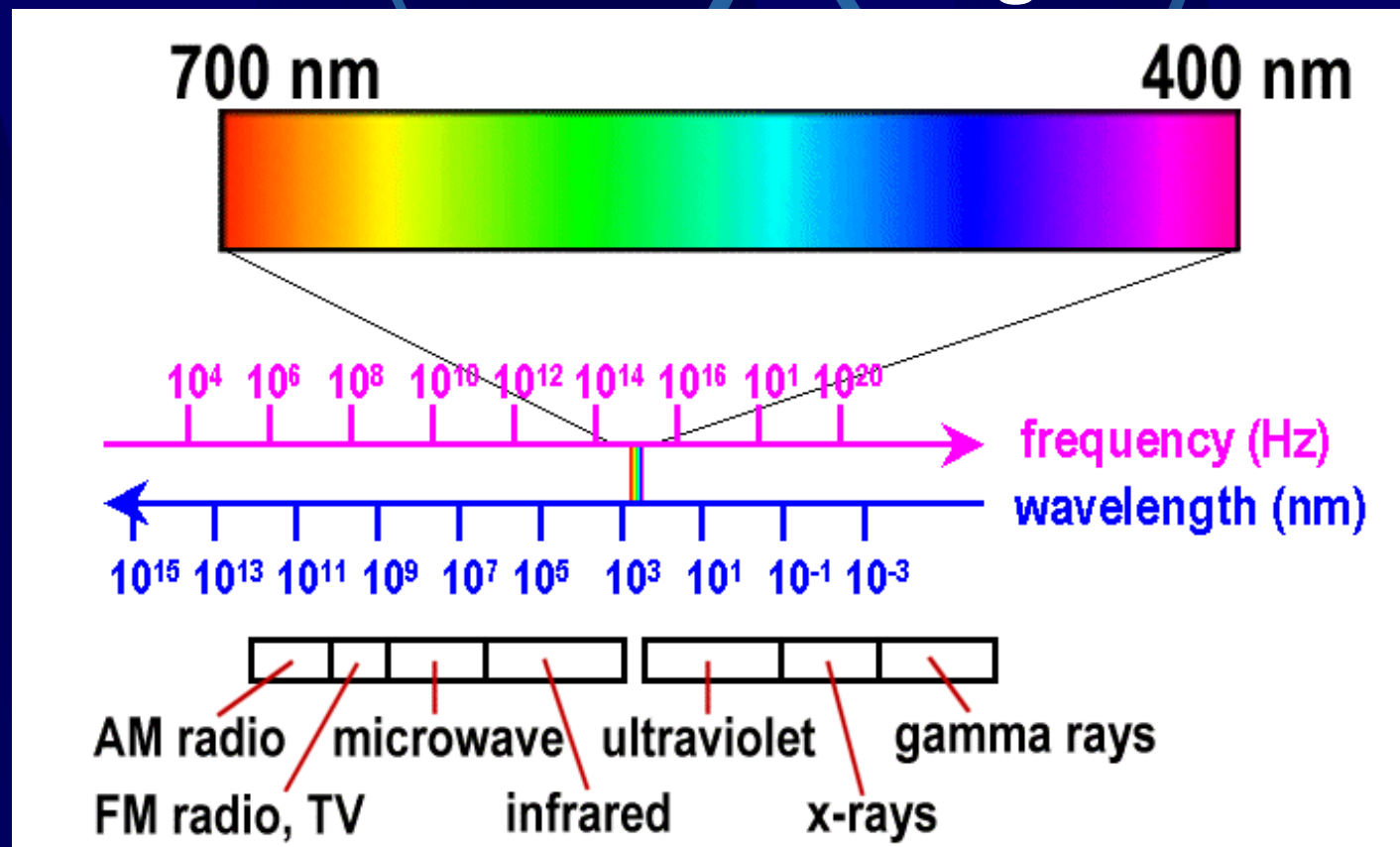
- Color CRTs are *much* more complicated
- Three electron guns
- Less bright than monochrome CRTs
- How do we represent Color in Graphics Systems ?

Elements of Color



Visible Spectrum

- We perceive electromagnetic energy having wavelengths in the range 400-700 nm as *visible light*

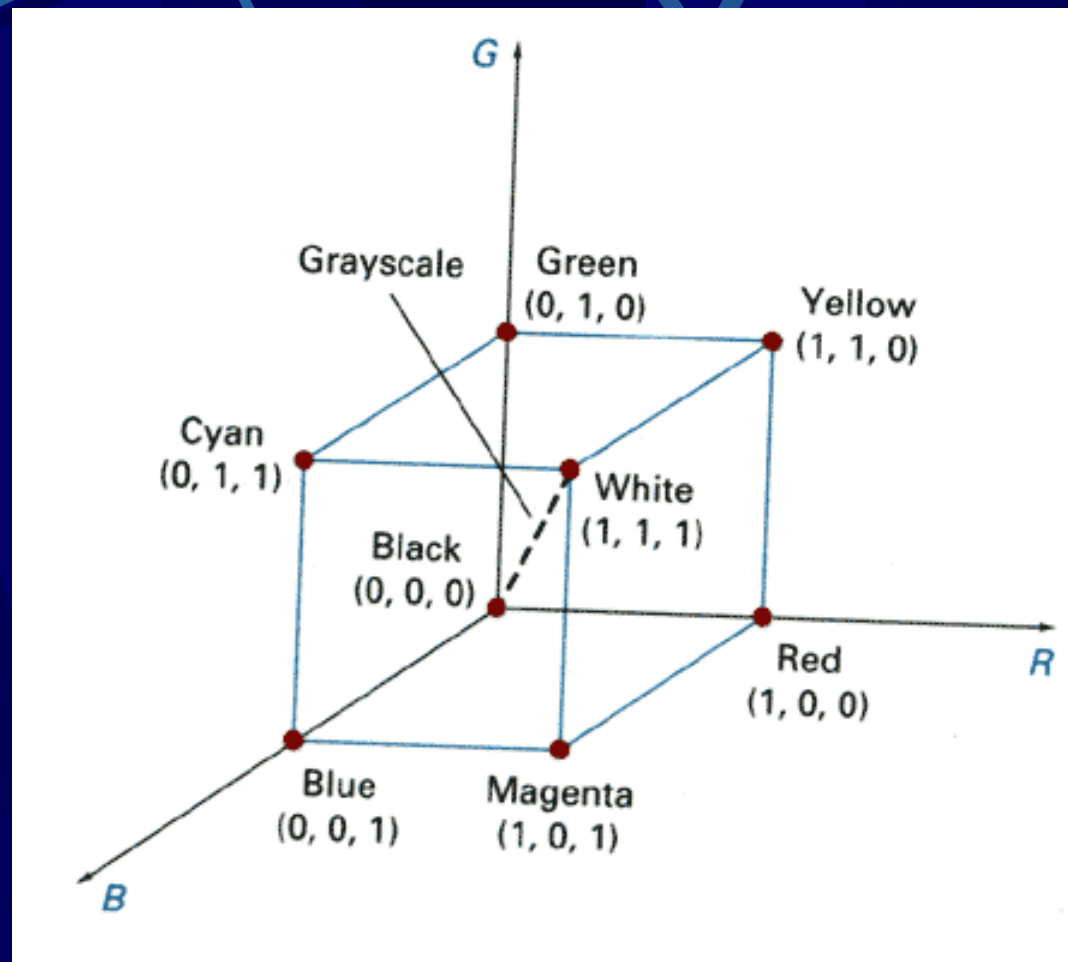


Raster Display

- How to describe Color – Color Models
- Additive Color Model: adding 3 primary colors
- Valid for emitting light sources Displays
- Primary Color
 - Various possibilities
 - Most popular - **R** **G** **B**

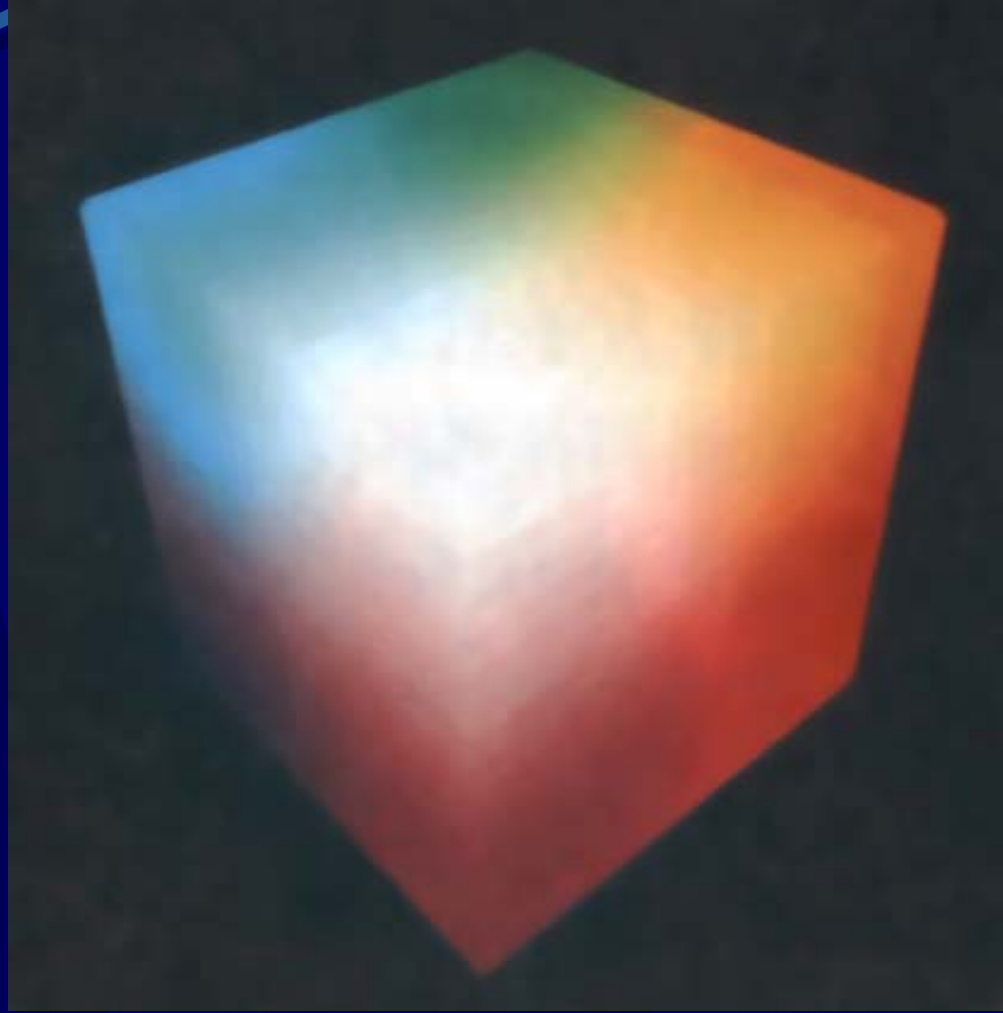
Raster Display

- Color Model - **R** **G** **B**



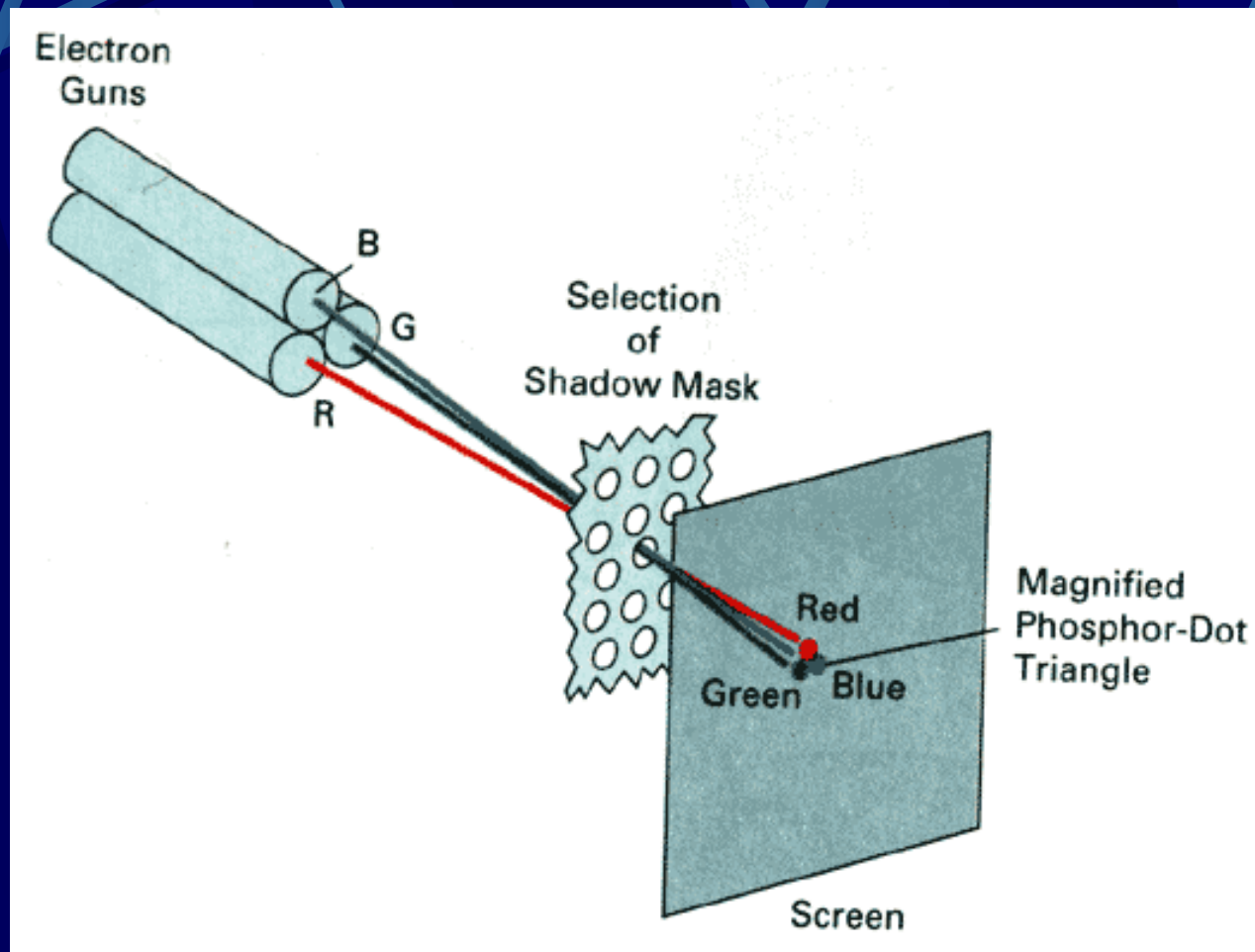
Raster Display

- Color Model - **R** **G** **B**



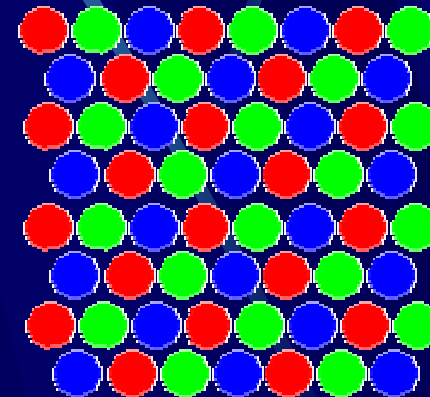
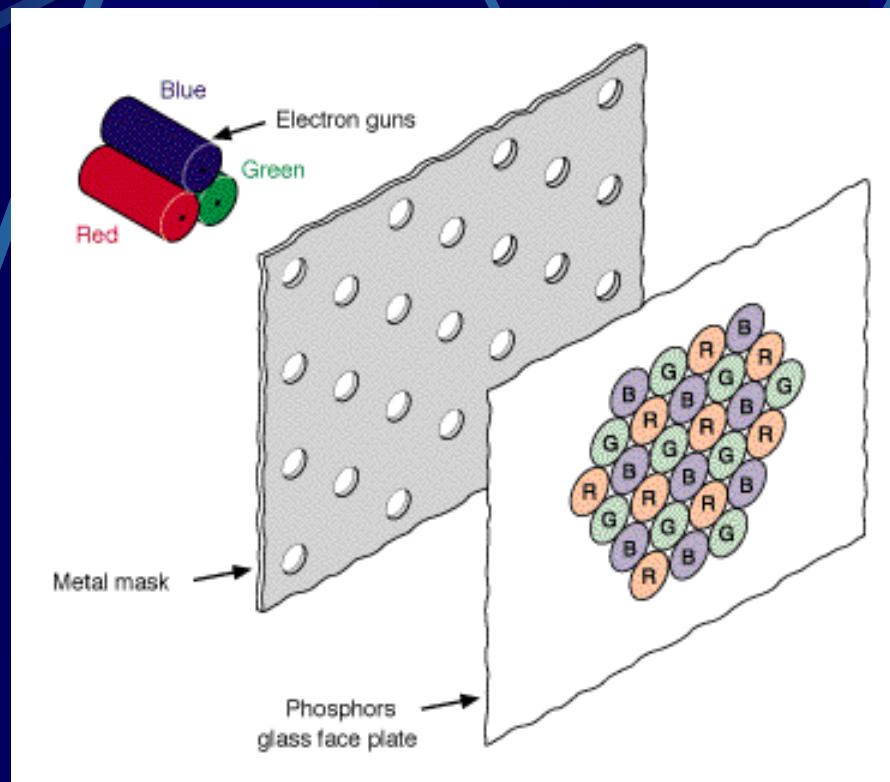
Raster Display

- How does it work



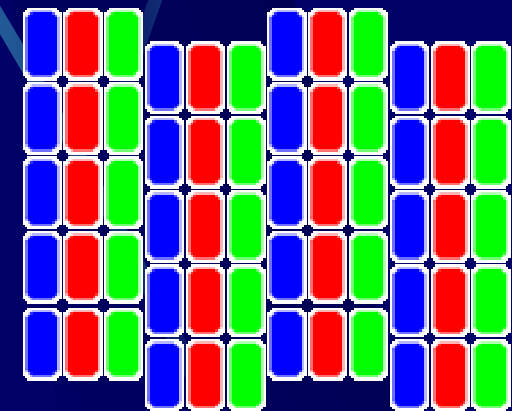
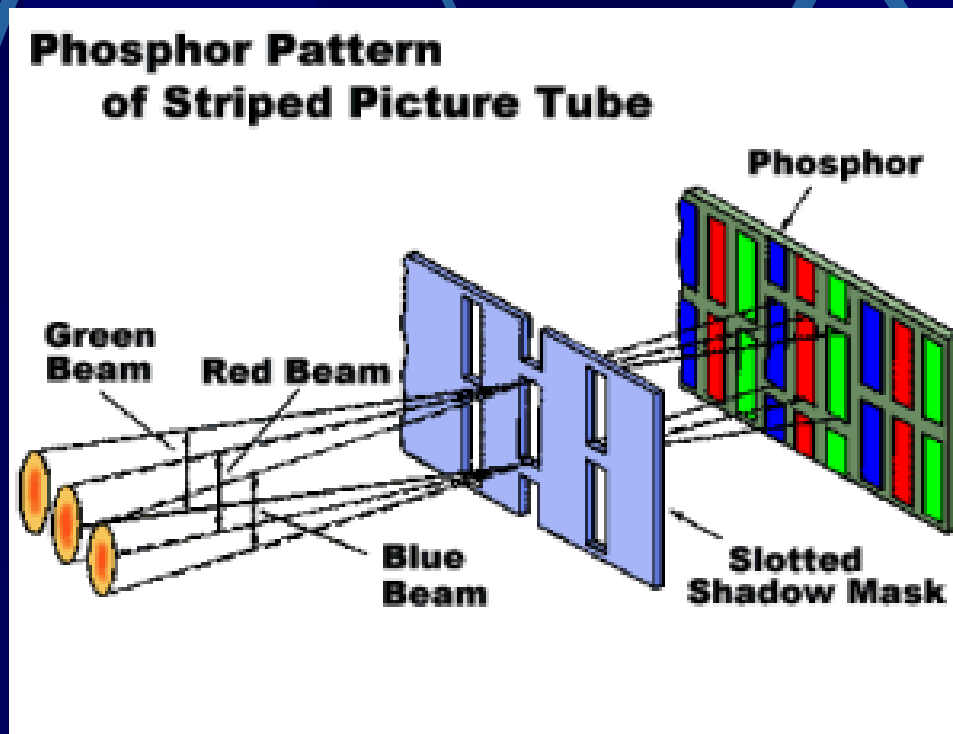
Raster Display

● Delta Electron Gun Arrangement



Raster Display

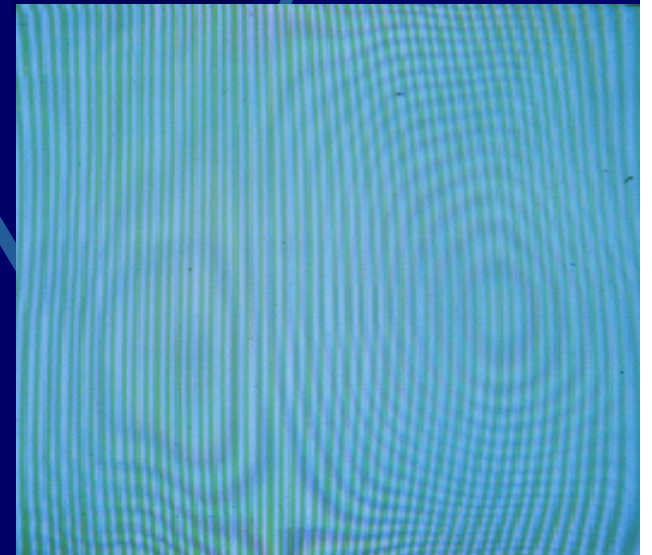
- In-line Electron Gun Arrangement



Raster Display

Disadvantages

- Requires screen-sized memory array
- Discrete spatial sampling (pixels)
- Moire patterns result when shadow-mask and dot-pitch frequencies are mismatched
- Convergence (varying angles of approach distance of e-beam across CRT face)
- Limit on practical size (< 40 inches)
- Spurious X-ray radiation
- Occupies a large volume



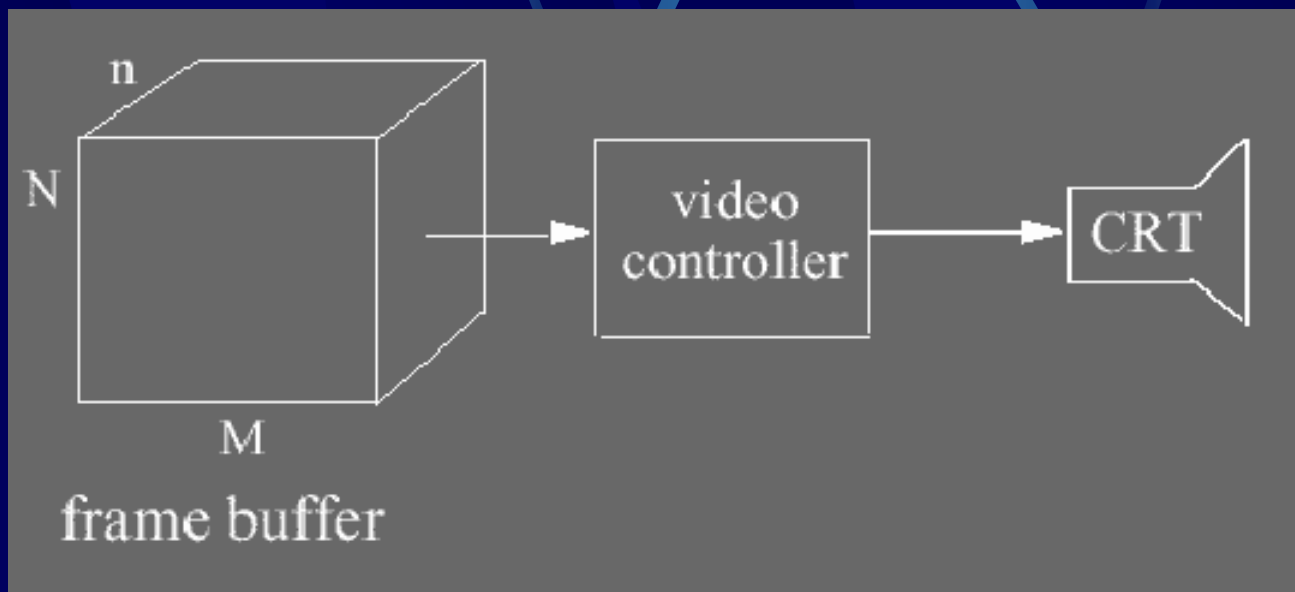
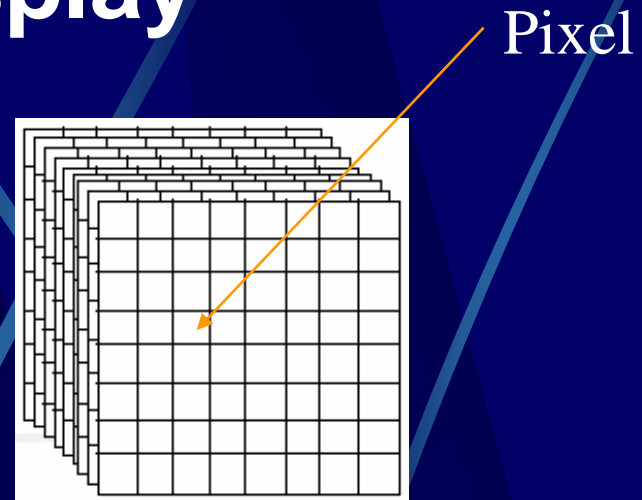
Raster Display

● Advantages

- Allows solids to be displayed
- Leverages low-cost CRT H/W (TVs)
- Whole Screen is constantly updated
- Bright light-emitting display technology

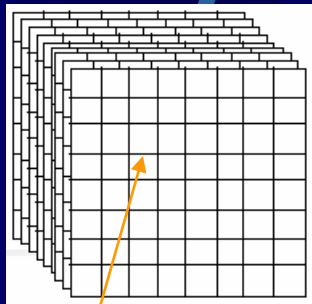
Raster Display

- Color Display
- Frame Buffer – organized in Bit planes
- n Bit planes $M * N$ Pixels

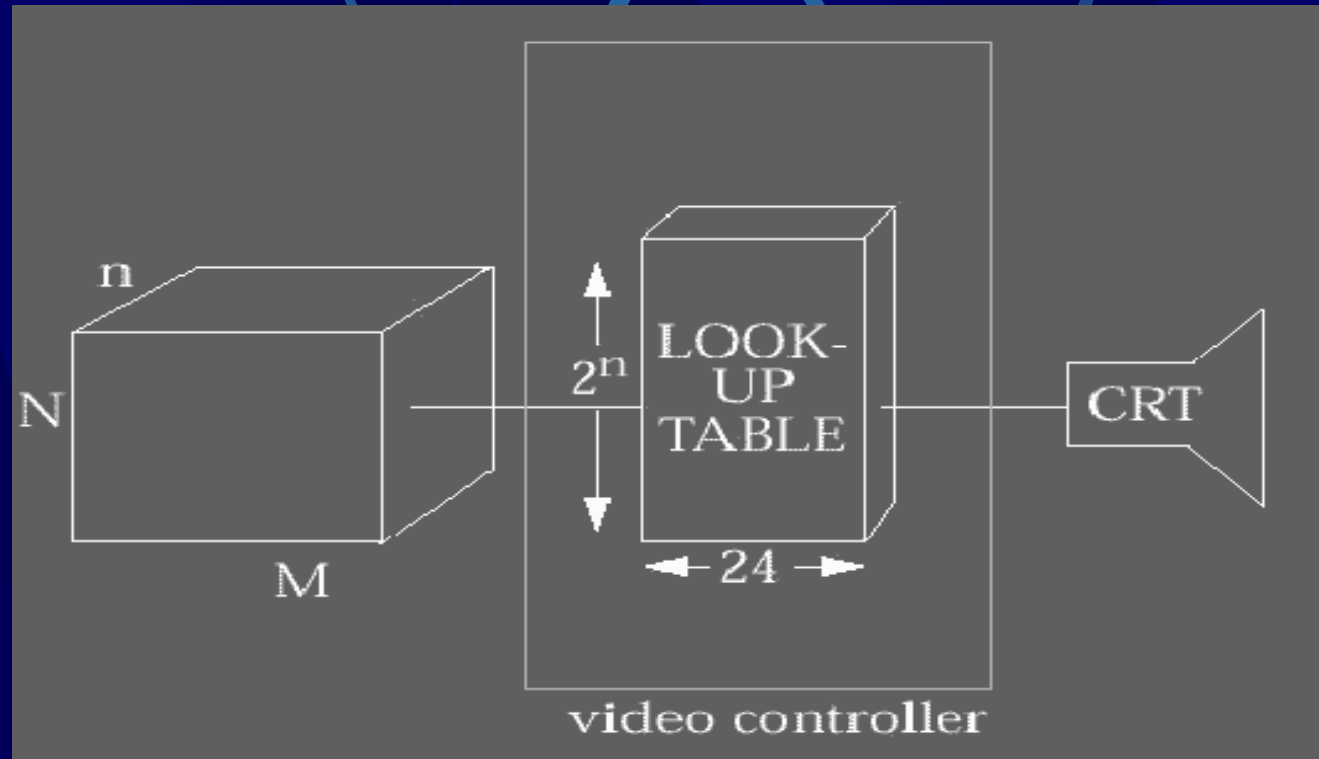


Raster Display

- Color Display– Video Lookup Table
- True color
 - Each primary color is represented with 8 bits
 - Total 3 colors * 8 Bits = 24 Bits/Pixel

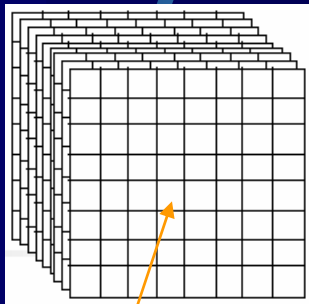


Pixel

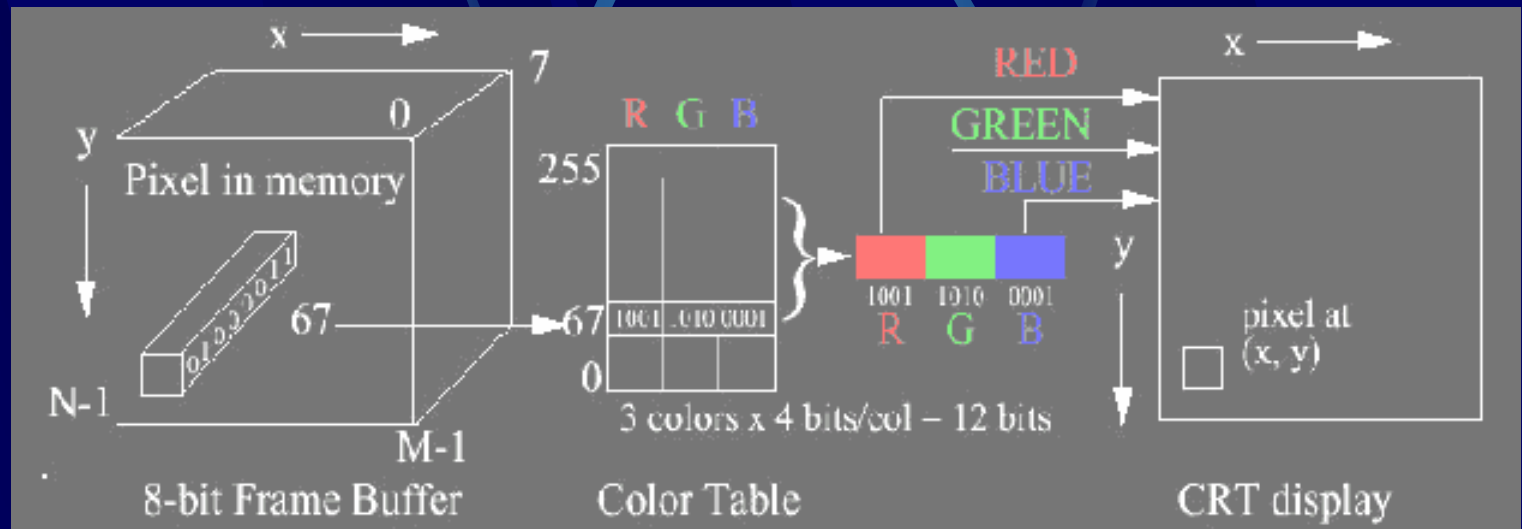


Raster Display

- Represent the Color:
- Video Lookup Table: 3 Colors * 4 Bits = 12 Bits
- Frame buffer 8 Bit planes (n=8)
- $2^8 = 256$ Color Indices

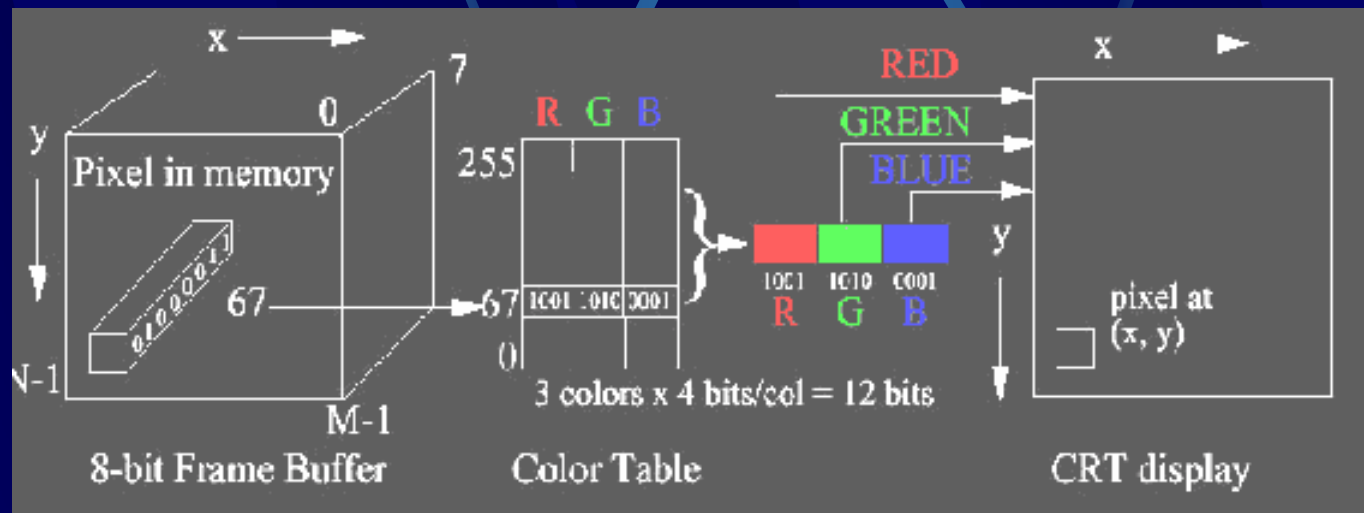


Pixel



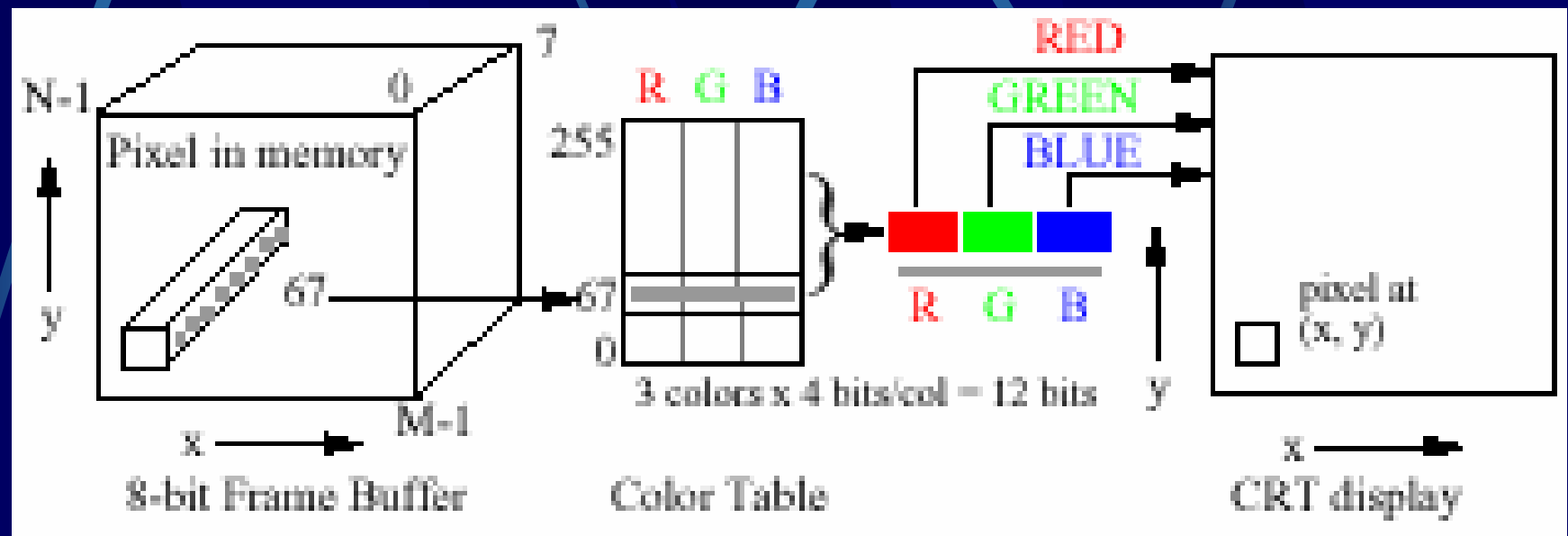
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Graphics Devices

- Principles and Constraints

- Hardware

 - Standard

 - Graphics Devices

 - Output

 - Display
 - Printer
 - Plotter

 - **Input**

 - Various Types

Input Graphics Devices

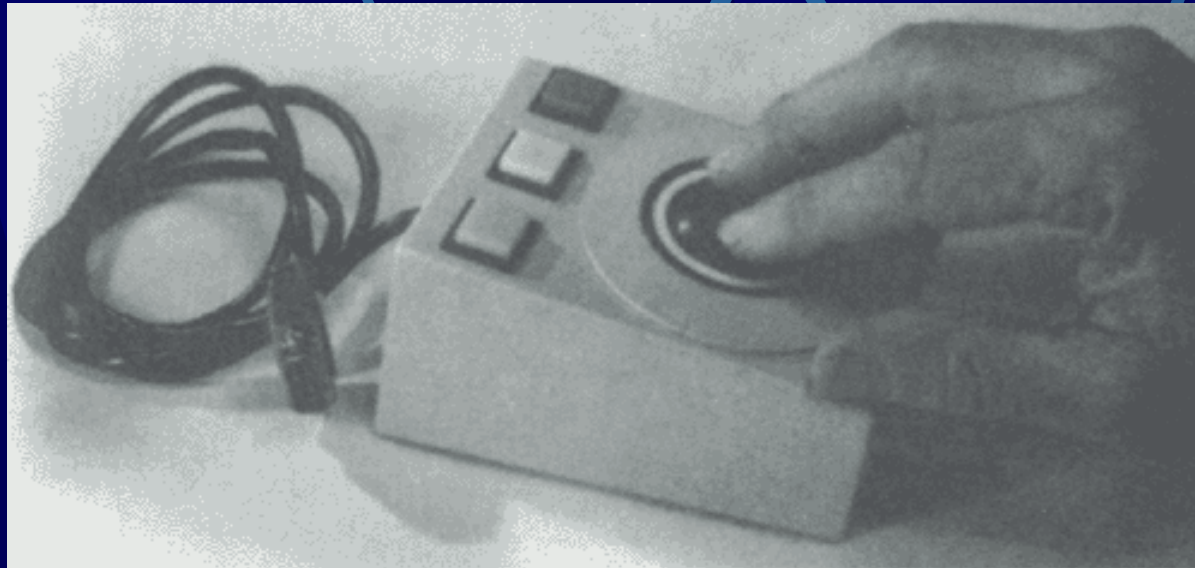
● Physical Devices

● Various Types

- Keyboard
- Mouse
- Trackball
- Joystick
- Data glove
- Digitizer
- Scanner – 2D, 3D
- Light Pen

Input Graphics Devices

- Physical Devices
 - Trackball



Input Graphics Devices

- Physical Devices
 - Z-Mouse



Input Graphics Devices

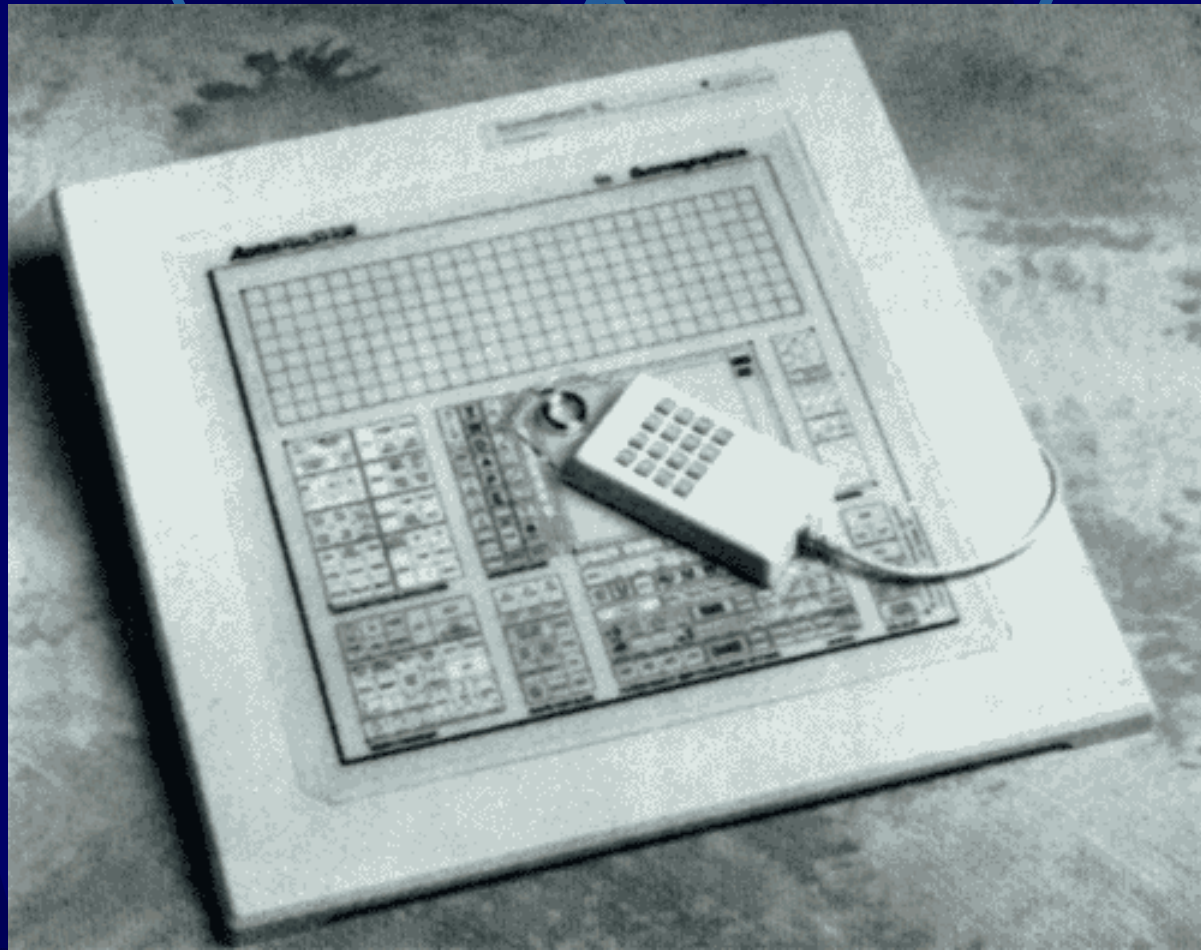
- Physical Devices
 - Data Glove



Input Graphics Devices

- Physical Devices

- Digitizer



Input Graphics Devices

- Physical Devices

- Scanner – 3D



Input Graphics Devices

● Logical Devices

- Locator
- Selector
- Choice
- Text
- Valuator

Input Graphics Devices

● Logical Devices

- Logical Devices

Locator, to indicate a position and/or orientation

- Pick (select), to select a displayed entity
- Valuator, to input a single value in the space of real numbers
- Keyboard, to input a character string
- Choice, to select from a set of possible actions or choices

Input Graphics Devices

- Implementation of Logical Devices
 - Locator Devices: Tablet, Mouse, Trackball, Joystick, Touch Panel, Light Pen
 - Keyboard devices: Alphanumeric keyboard (coded - get single ASCII character, unencoded - get state of all keys - more flexible)
 - Valuator Devices: Rotary dials (Bounded or Unbounded), Linear sliders
 - Choice Devices: Function keys

Input Graphics Devices

● Input Modes

- Request
- Sample
- Event

Event Mode

- Generate initial display

repeat

- Enable selection of commands and objects
(Program pauses and waits until user acts)

wait for user selection

case on selection

- Process selection to process command
- Update model and screen as needed

until quit (User has selected the quit command)