CSE 4201
Lecture 02

Overview of Graphics Systems

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Video Display Devices

- Cathode-ray tube (CRT) Monitor
- Rater-Scan Displays
- Random-Scan Displays
- Color CRT Monitors
- Flat-Panel Displays

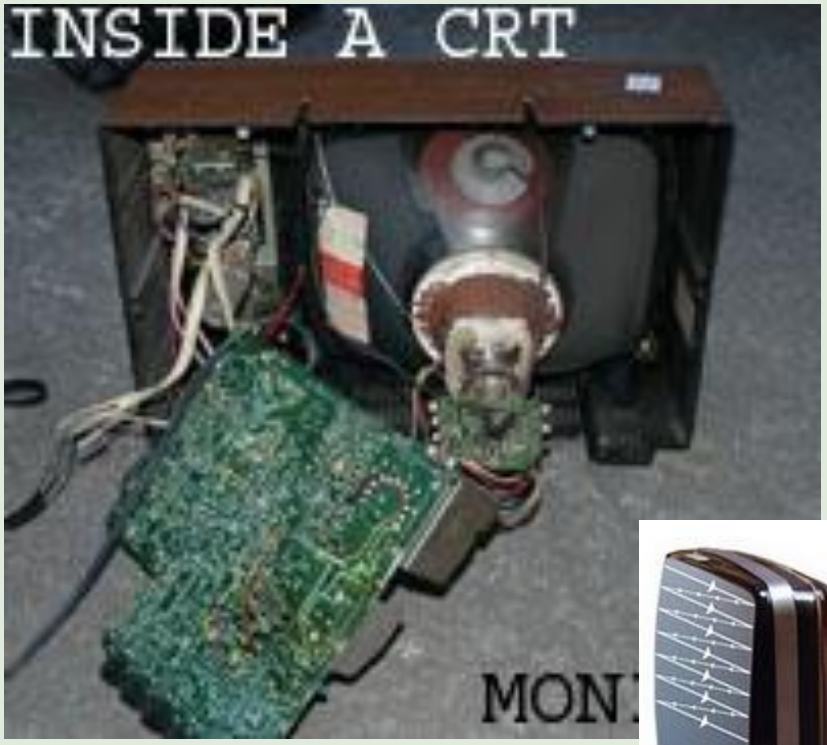
WHAT IS A PIXEL/PEL?

- SMALLEST ADDRESSIBLE SCREEN ELEMENT IS KNOWN AS A PIXEL OR PEL.
- **RESOLUTION**: THE MAX NUMBER OF POINTS THAT CAN BE DISPLAYED WITHOUT OVERLAP IS REFERRED TO AS RESOLUTION.
- NUMBER OF POINTS PER CM THAT CAN BE PLOTTED HORIZONTALLY AND VERTICALLY
- EXAMPLE 1024X640(HORIZONTAL &VERTICAL)

Cathode-ray tube (CRT) Monitors

- **Primary output device – Video monitors**
  - **Standard design of video monitor: Cathode-ray tube (CRT)**

Cathode-ray tube (CRT) Monitors

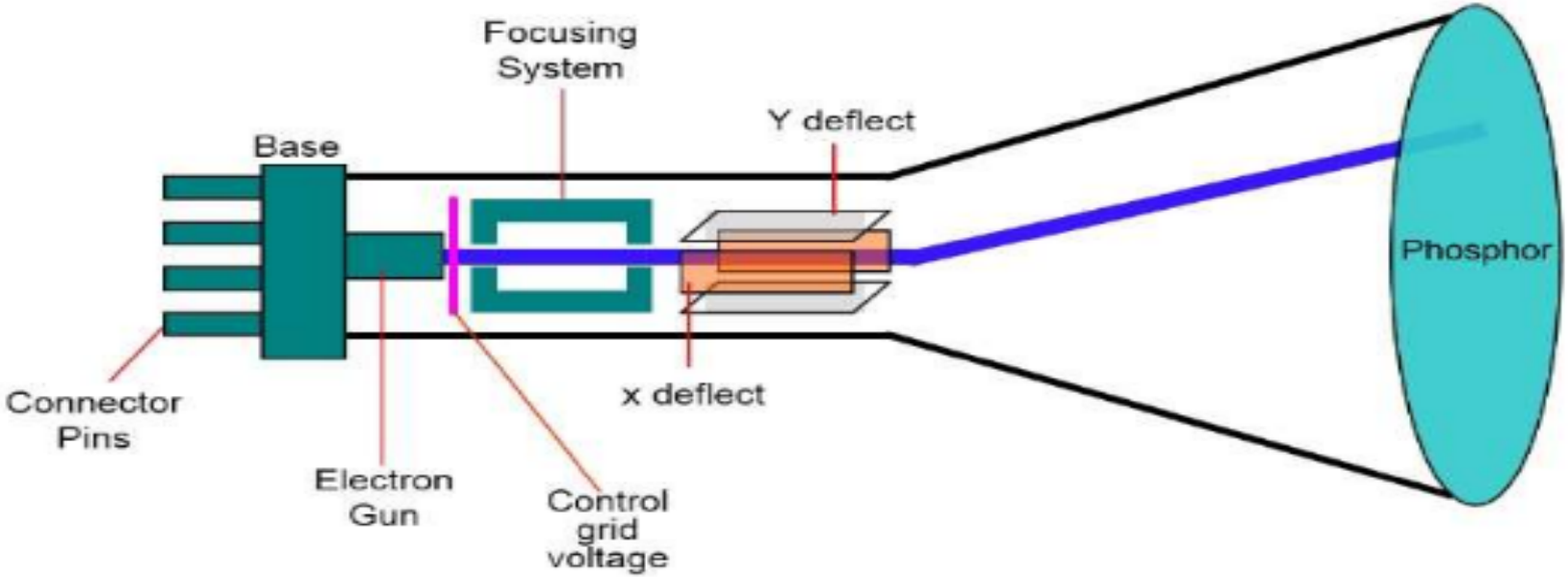


Cathode Ray Tube

The primary output device in a graphical system is the video monitor. The main element of a video monitor is the **Cathode Ray Tube (CRT),** shown in the following illustration.

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.

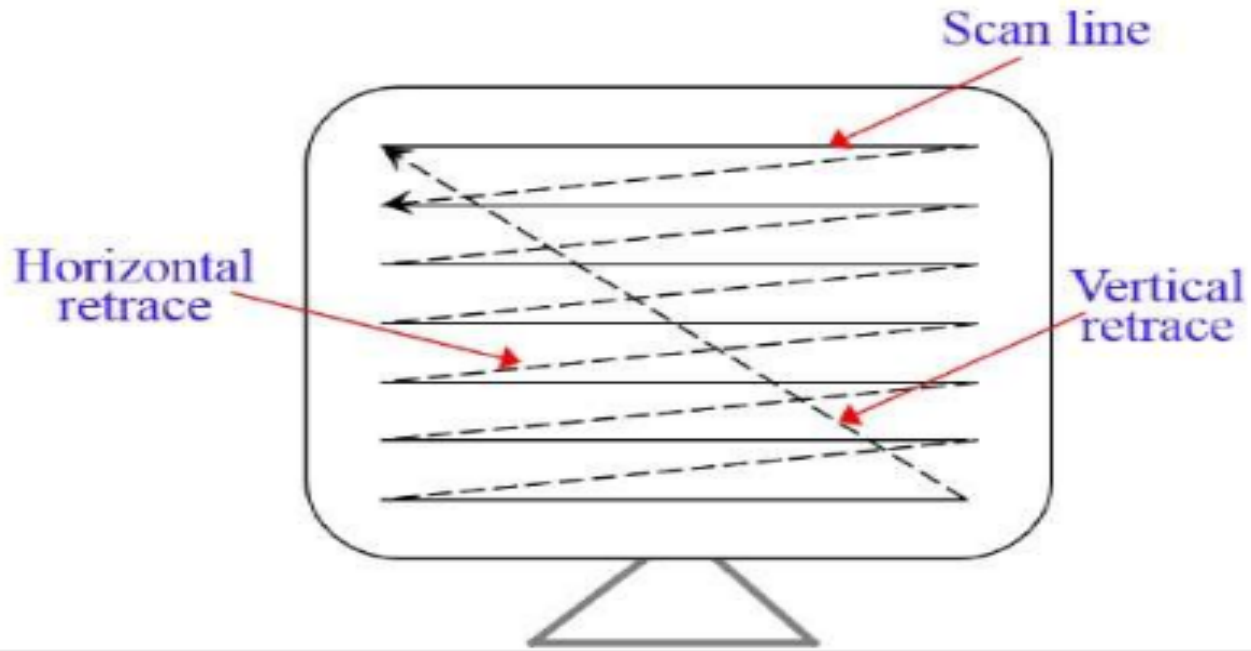


Raster Scan

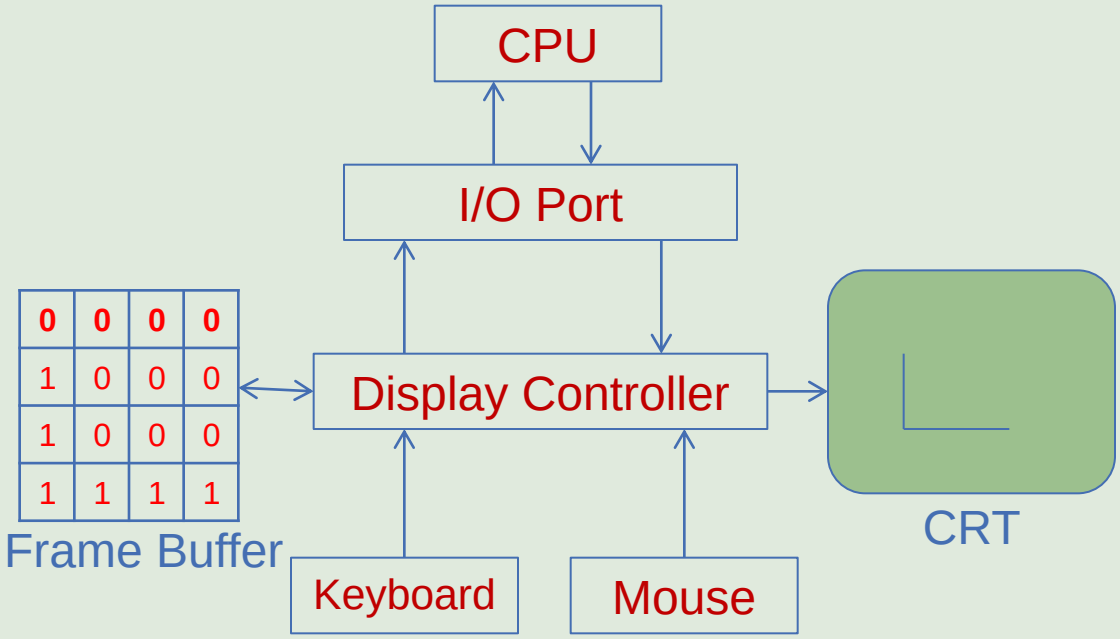
In a raster scan system, the electron beam is swept across the screen, one row at a time from top to bottom. As the electron beam moves across each row, the beam intensity is turned on and off to create a pattern of illuminated spots.

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 (scan line) at a time as shown in the following illustration.

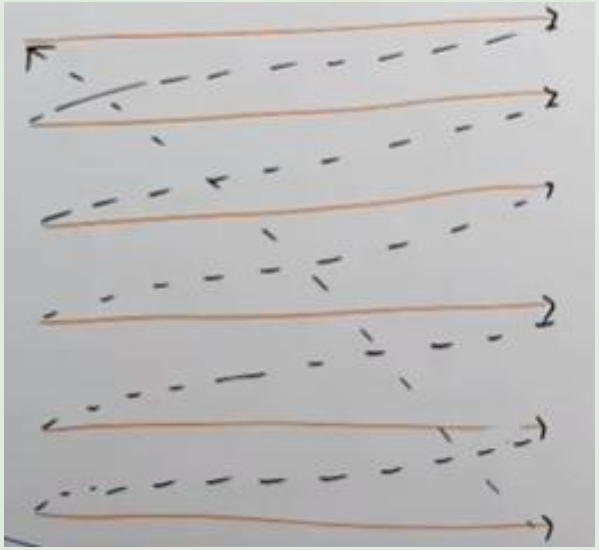
Each screen point is referred to as a **pixel (picture element)** or **pel**. At the end of each scan line, the electron beam returns to the left side of the screen to begin displaying the next scan line.



Structure Raster Scan



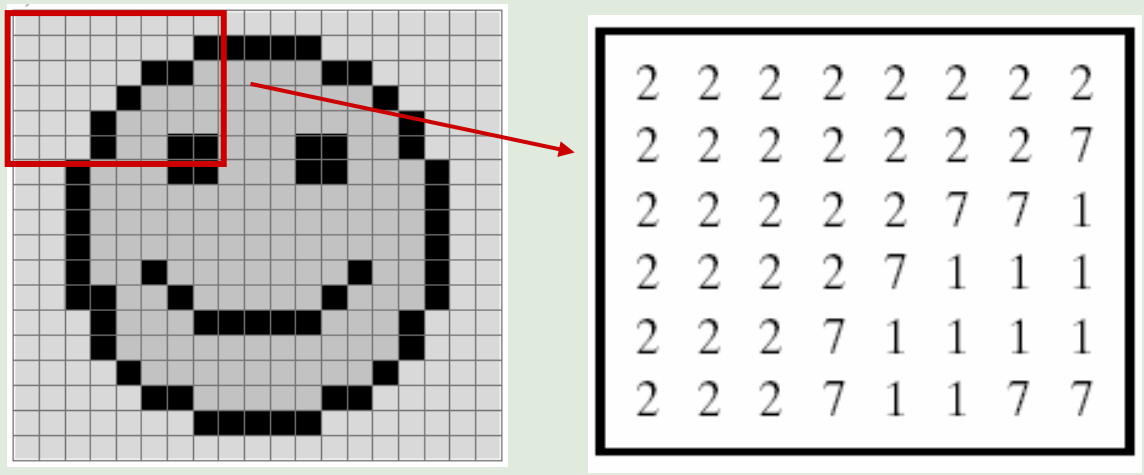
Display Controller
Scan each line
0: no display
1: glow pixel



CRT

CRT Display Principles

- Raster-Scan Displays
  - Picture elements: screen point referred as “Pixel”
  - Picture information stored in refresh (frame) buffer



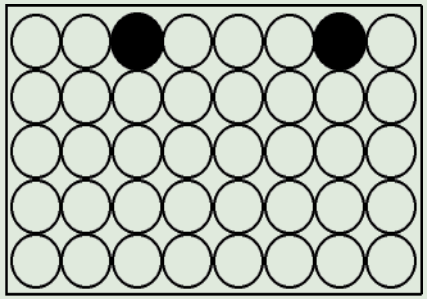
  - Picture information stored in refresh (frame) buffer
    - The number of bits per pixel in the frame buffer is called depth or bit planes
    - Buffer with 1 bit per pixel – Bitmap
    - Buffer with multiple bits per pixel – Pixmap
  - Interlaced refresh procedure
    - Beams sweeps across every other scan line

Move(2,0)
Line(4,4)
Move(-4,0)
Line(4,-4)

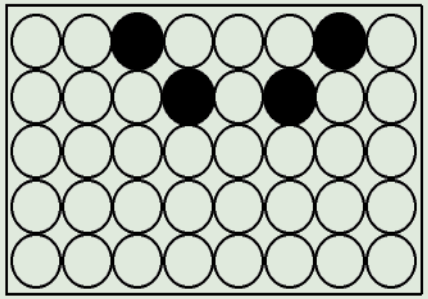
commands in
display list

00100010
00010100
00001000
00010100
00100010

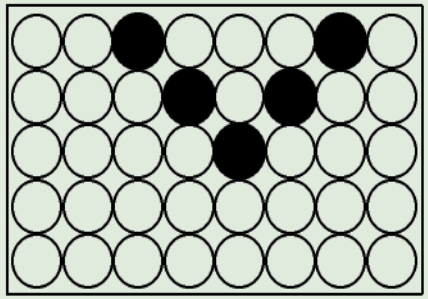
frame
buffer



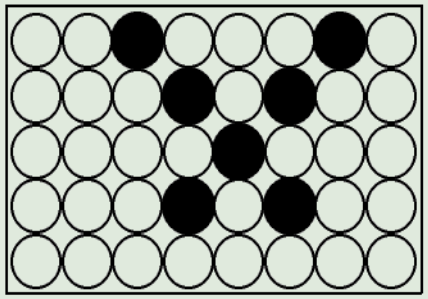
screen after
1 scan lines



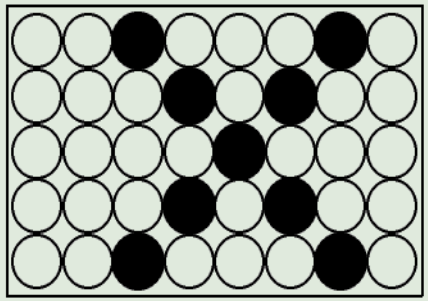
screen after
2 scan lines



screen after
3 scan lines

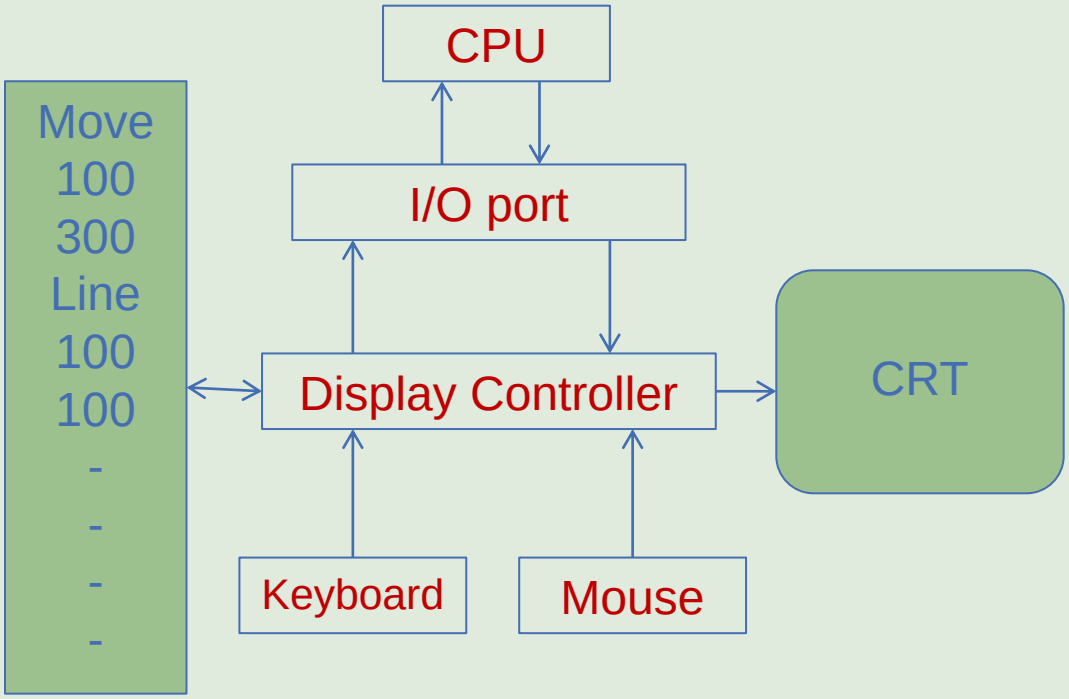


screen after
4 scan lines



screen after
5 scan lines

Structure Vector Scan



Display Buffer

Display Controller
Interprets commands, calculate coordinates

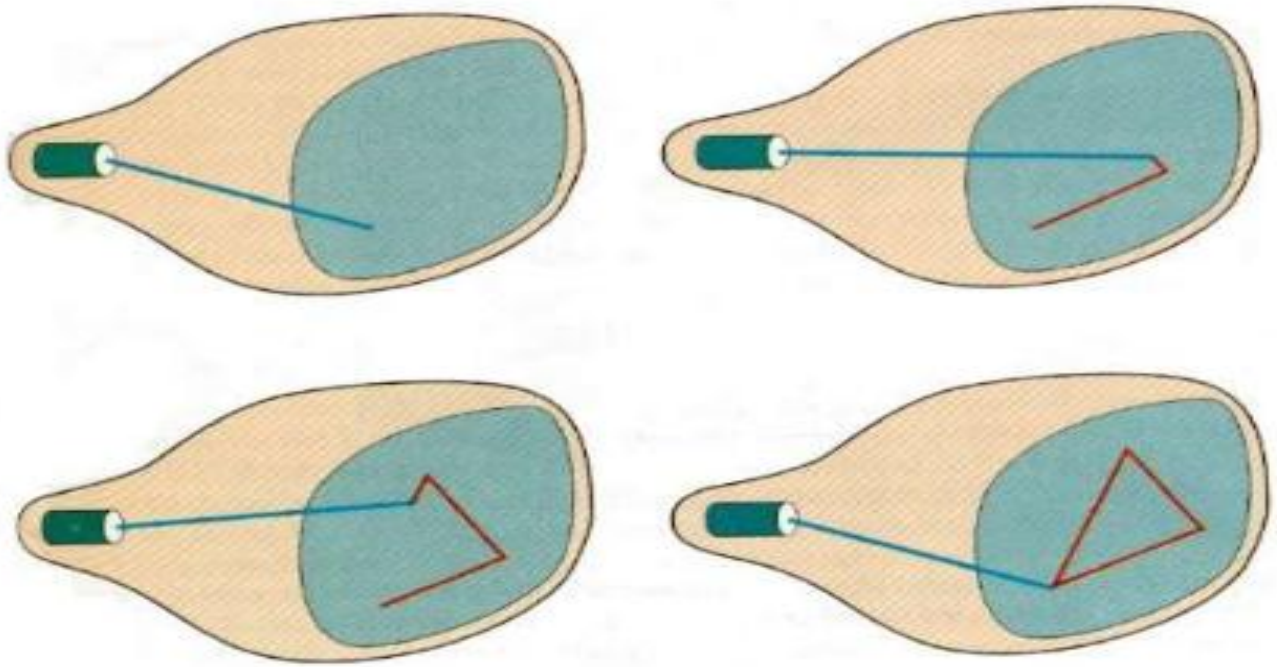
Vector Scan/Random Scan

Random Scan (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.



Difference (Vector vs Raster)

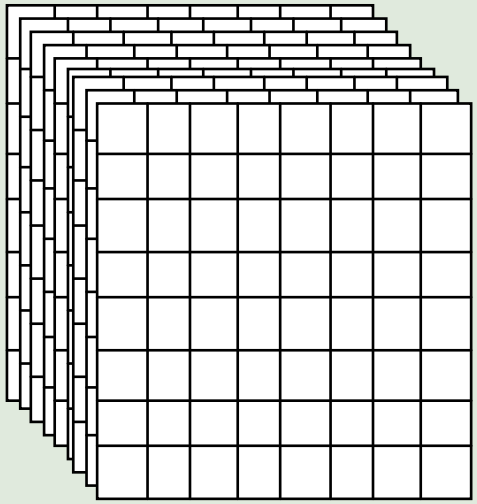
Vector	Raster
1. Use point, line, Character	Use pixel
2. Does not distorted after scaling	Distorted after scaling
3. Scan Conversion requires no Hardware	Scan Conversion requires Hardware
4. Small File size	Big File size
5. File format: . ai: Adobe Illustrator eps: Encapsulated post script pdf: Printable Document Format	File format: psd: Photoshop Document. png: Portable Network Graphics jpeg: Joint Photographic Expert Group gif: Graphic Interchange Format tif: Tagged Image Format

Definition

- **Refresh rate:** # of complete images (frames) drawn on the screen in 1 second. Frames/sec.
- **Frame time:** reciprocal of the refresh rate, time between each complete scan. sec/frame

Frame Buffer

- A frame buffer is characterized by size, x, y, and pixel depth.
- the **resolution** of a frame buffer is the number of pixels in the display. e.g. 1024x1024 pixels.
- Bit Planes or Bit Depth is the number of bits corresponding to each pixel. This determines the **color resolution** of the buffer.



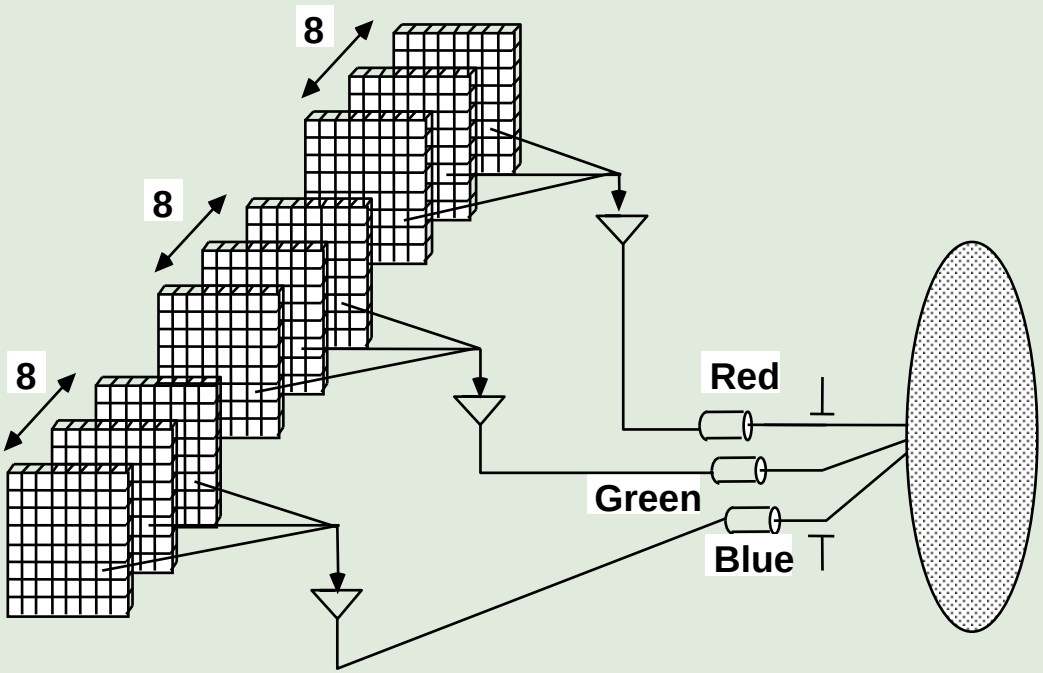
Bilevel or **monochrome** displays have 1 bit/pixel

8bits/pixel -> 256 simultaneous colors

24bits/pixel -> 16 million simultaneous colors

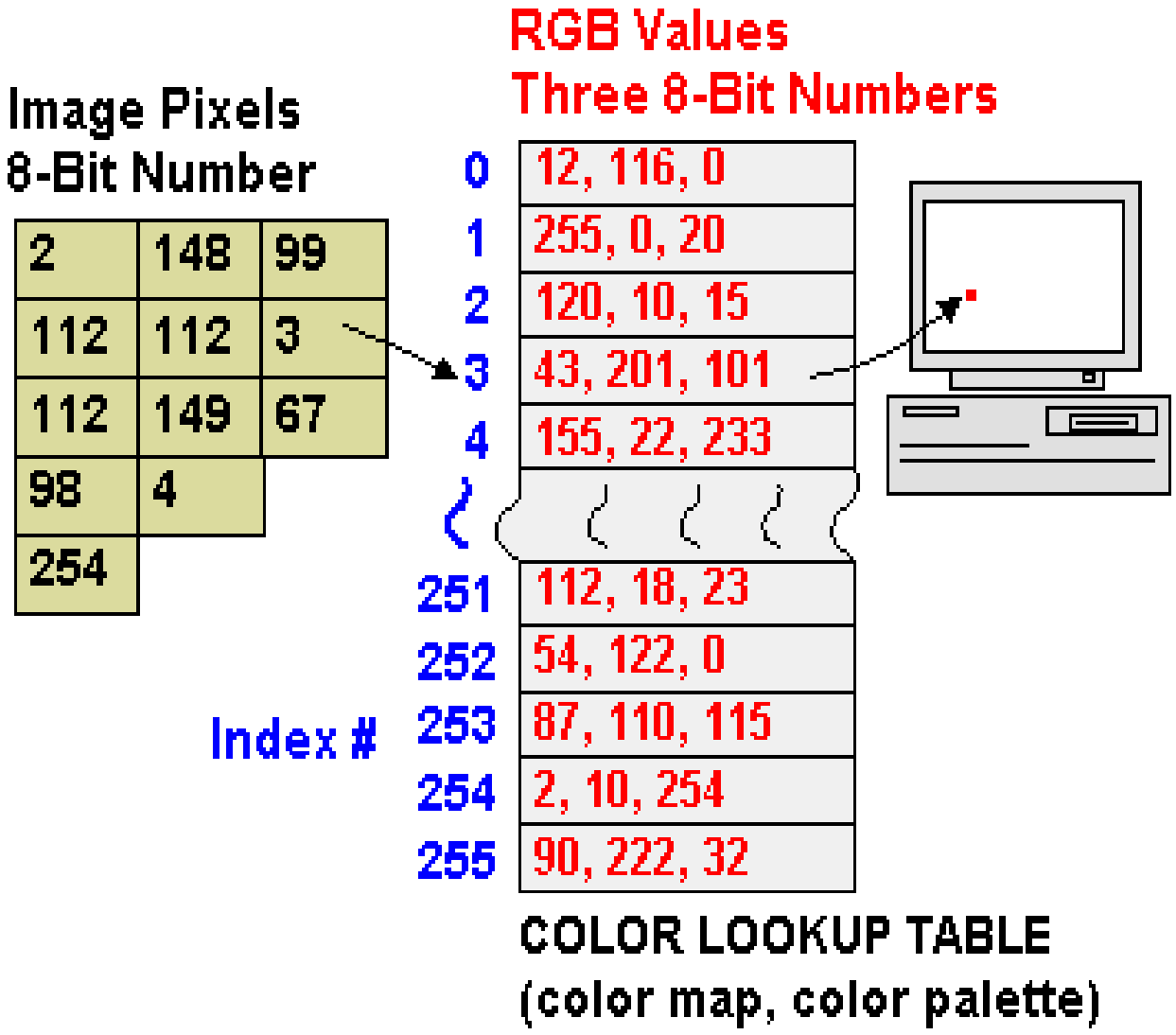
Specifying Color

- direct color :
  - each pixel directly specifies a color value
    - e.g., 24bit : 8bits(R) + 8bits(G) + 8 bits(B)
- palette-based color : indirect specification
  - use palette (CLUT)
    - e.g., 8 bits pixel can represent 256 colors



24 bits plane, 8 bits per color gun.

2^{24} = 16,777,216



Interlaced Scanning

- Scan frame 30 times per second
- To reduce flicker, divide frame into two fields—one consisting of the even scan lines and the other of the odd scan lines.
- Even and odd fields are scanned out alternately to produce an interlaced image.

Interlaced

Odd lines
Field 1

Even lines
Field 2

Field 1 + Field 2 = Frame (complete image)

Display Rate: 60 fields per second (North America)

SOME IMPORTANT TERMS

1. **ASPECT RATIO**:

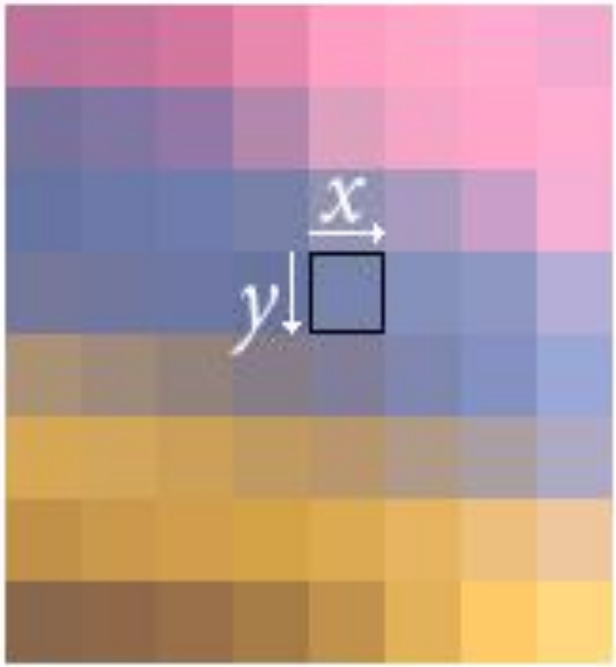
THE RATIO OF VERTICAL POINTS TO THE HORIZONTAL POINTS NECESSARY TO PRODUCE EQUAL LENGTH LINES IN BOTH DIRECTIONS ON THE SCREEN.

2. **FRAME BUFFER**:

THE MEMORY WHREIN THE PICTURE DEFINITION IS STORED IS KNOWN AS FRAME BUFFER(REFRESH BUFFER). THIS M/M AREA HOLDS THE SET OF INTENSITY VALUES FOR ALL THE SCREEN POINTS.

Frame aspect ratio (FAR) = horizontal/vertical size

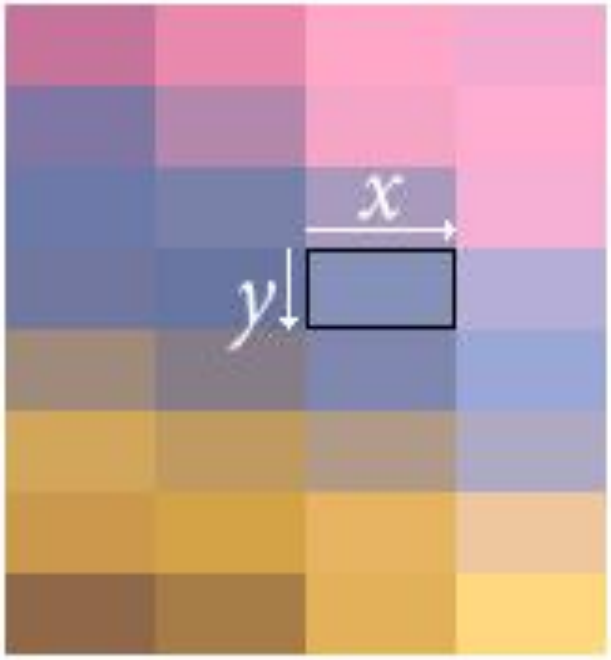
TV	4:3
HDTV	16:9



Pixel Aspect Ratio

PAR = x/y = 1:1

x = pixel width
y = pixel height



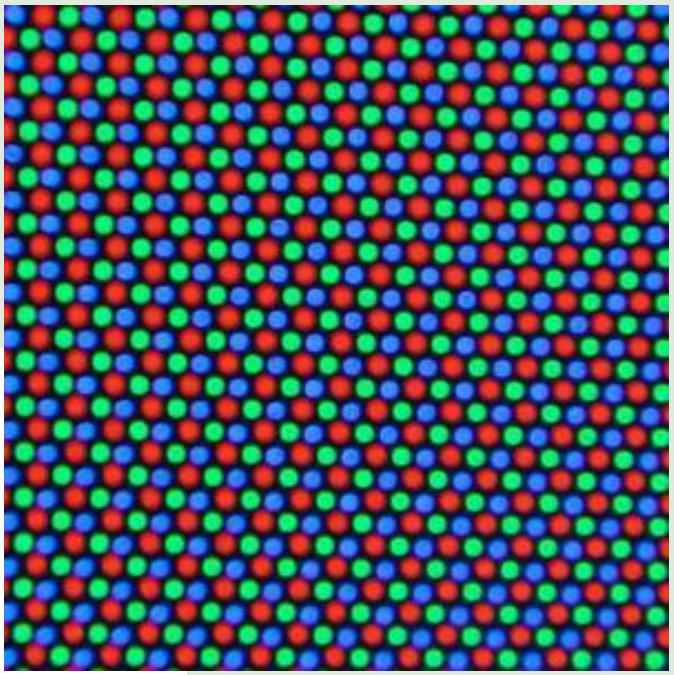
Pixel Aspect Ratio

PAR = x/y = 2:1

x = pixel width
y = pixel height

Color CRT Monitors

- Operation of delta-delta, shadow mask CRT



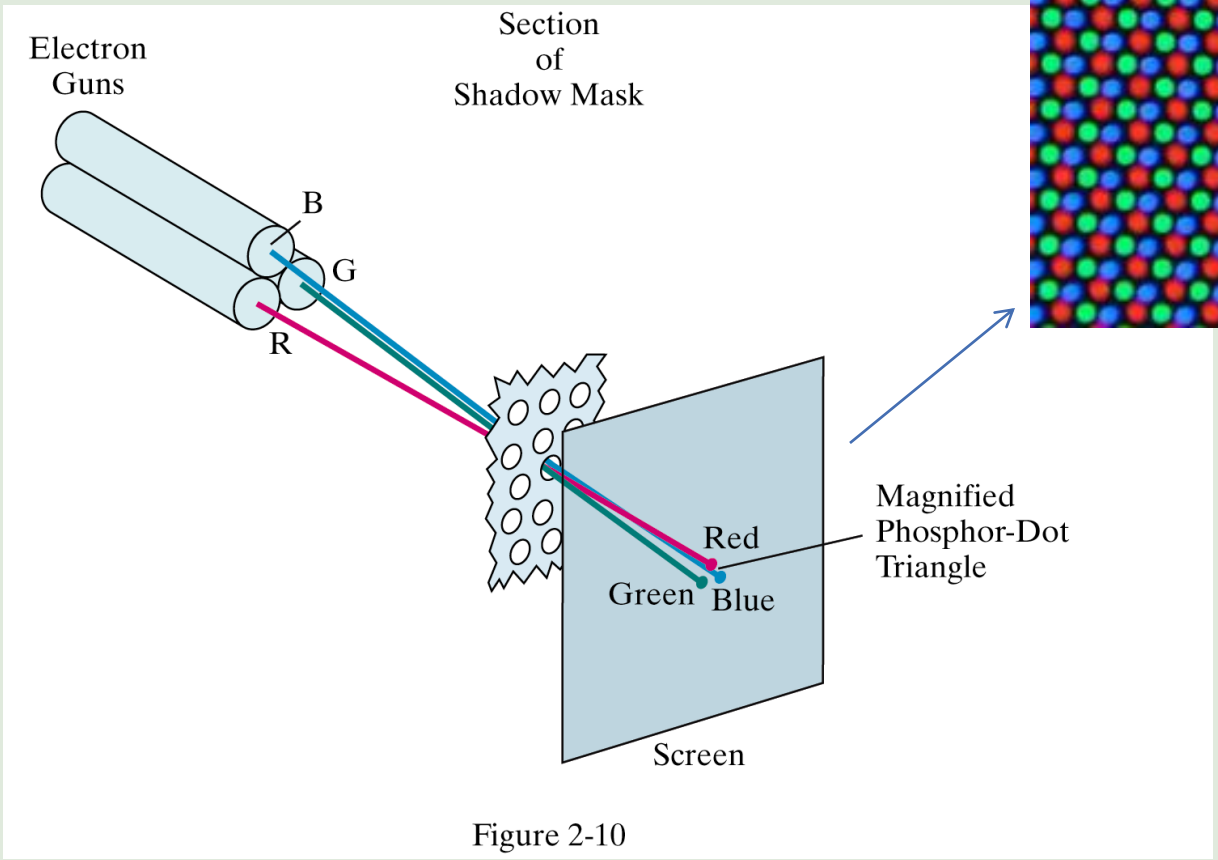


Figure 2-10

Group Presentation

Present in the next class (5 minutes for each)

- CRT Display
- LCD
- Smart Display (TV)
- Plasma Display
- Touch Screen