Computer Graphics and Multimedia Techniques

Lecture - 1

- Visualization — Representation of an object as image.

1. Introduction to Computer Graphics :-

- Computer graphics involves display, manipulation and storage of pictures and experimental data for proper visualization using a computer. (Art of drawing pictures on computer screen)

- Computer graphics system could be active or passive.

active	passive
O/p is a static scene or animated scene <u>ex</u> games	Observer has no direct control over the picture <u>ex</u> Television

- Computer graphics is a complex and diversified technology. The end product of computer graphics is a picture. The picture may be used for variety of purposes <u>ex</u> :- Engineering drawing, business graph, an architectural rendering for a proposed construction etc.

- Picture, thus is a fundamental cohesive concept in computer graphics, in broadest sense means any collection of lines, points, text etc. displayed on a graphics device. [The collective effects of the pixels taking on different color attributes give us what we see as a picture]

- Applications of Computer graphics :-
  CAD, GUI, DTP, Entertainment, Cartography, Multimedia Digital Image processing, Education and Training.

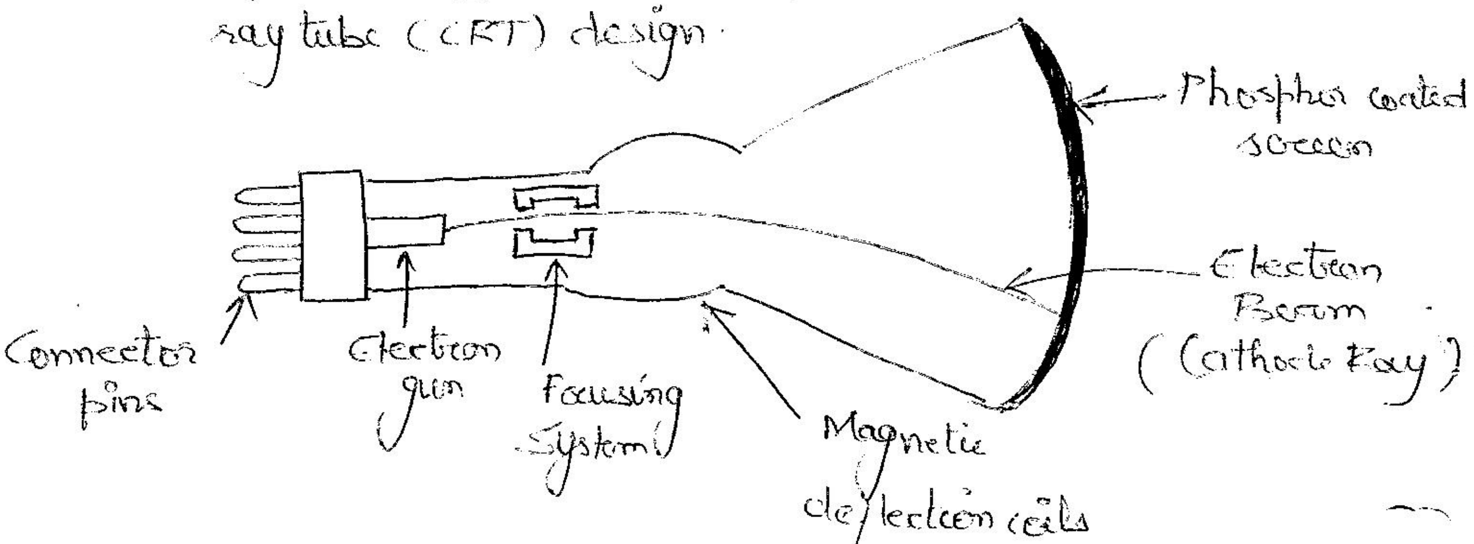
(CG → creation & synthesis of pictures * DIP → modification of pictures

- Graphics system comprises of a host computer, with support of a fast processor, large memory, frame buffer, and few hardware components as:
  - Display devices
  - Input devices
  - Output devices

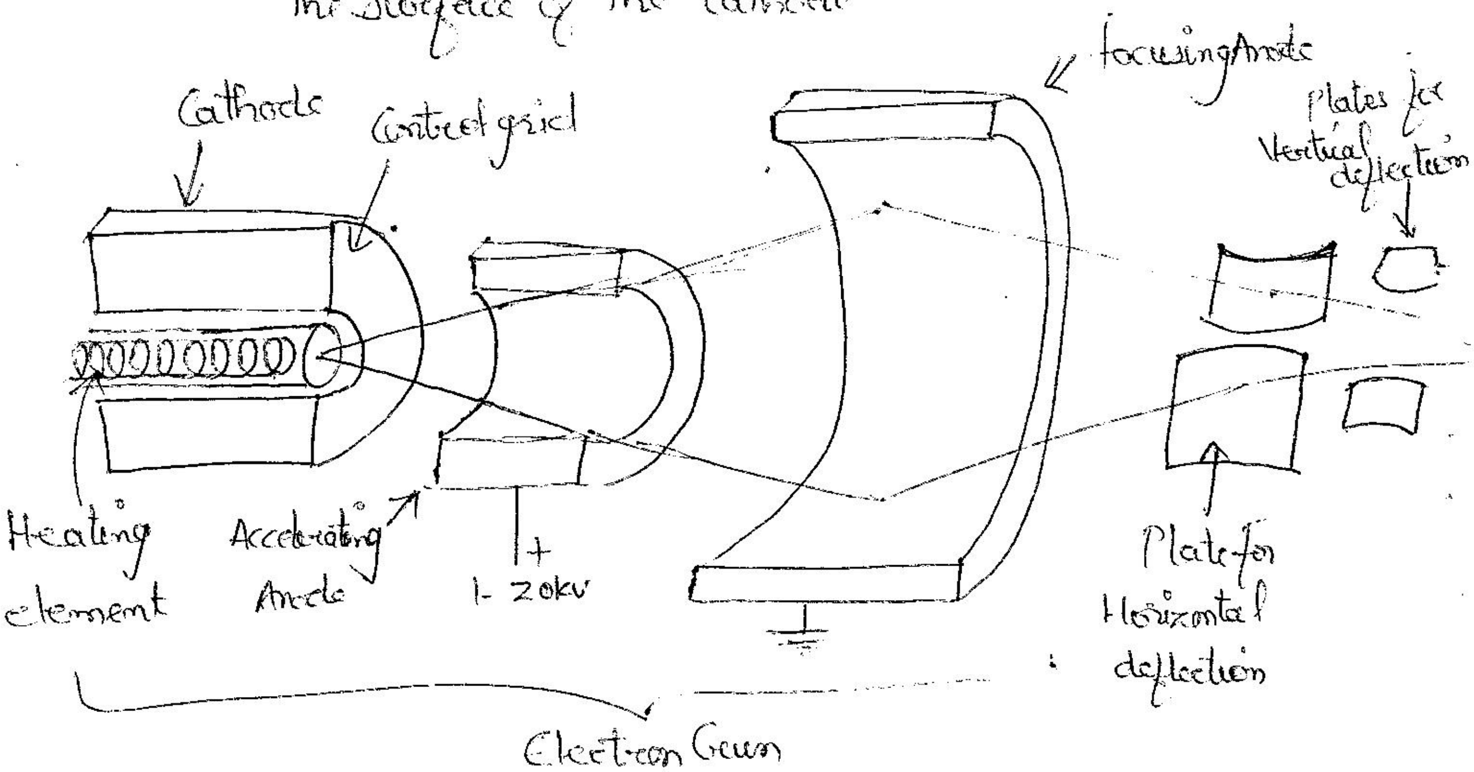
The light given off by the phosphor during exposure to the e⁻ beam is known as fluorescence.
The continuing glow given off after the beam is removed is phosphorescence.

2) Display Devices

* Operation of most display devices depends on the cathode ray tube (CRT) design.



⇒ Electron gun when heated to a high temperature under pressure of 0.01 Pa (10^{-7} atm), electrons evaporate from the surface of the cathode



The voltage difference between Cathode and Anode gives rise to an Electric field from directed from Right to Left between Acc. Anode and Cathode

⇒ The electron gun emits a beam of electron or cathode rays which passes through focusing system and magnetic deflection coils and finally hits the phosphor coated flourescent screen.

Phosphor then emits small spots of light, which fades away very rapidly, so to avoid, repetitive striking the beam on same point is required.

→ Control grid :- Control intensity of electrons (Brightness of display)

→ focusing Anode :- electrons gets dispersed all over the screen because of repulsion among the electrons.

→ Magnetic Deflection :- using 2 pairs of magnetic coils within the CRT.

→ Horizontal deflection plates provides vertical deflection to the electron beam, and vertical deflection plates provide horizontal deflection to the electron beam.

Important Terms

1) Dot pitch :- Distance between two phosphor dots of the same color.
2) Persistence :- Time taken by emitted light to decay
3) Refresh Rate :- No of times image is reproduced in one second.
4) Resolution :- dpi
5) Aspect Ratio :- Ratio of VP to HP

Monitor Icon	*Description of icon function*
Power Management	**Power Management:** Allows the user to define the power management settings through the monitor itself and not the software.
Monitor Status	**Monitor Status:** Displays the current monitor settings such as refresh rate and other settings.
Language	**Language:** Sets the language.

2.2.2 Pixel

The image is displayed as a collection of phosphor dots of regular shapes. These regular shapes are called *pixels(picture elements/pels).* The pixels could be rectangles, circles, squares.

A pixel is the smallest addressable portion of an image or display that a computer is capable of printing or displaying.

Figure 2.5 illustrates each pixel as unit square area identified by the coordinates of its lower left corner. The origin of the referenced coordinate system is located at the lower left corner of the display screen.

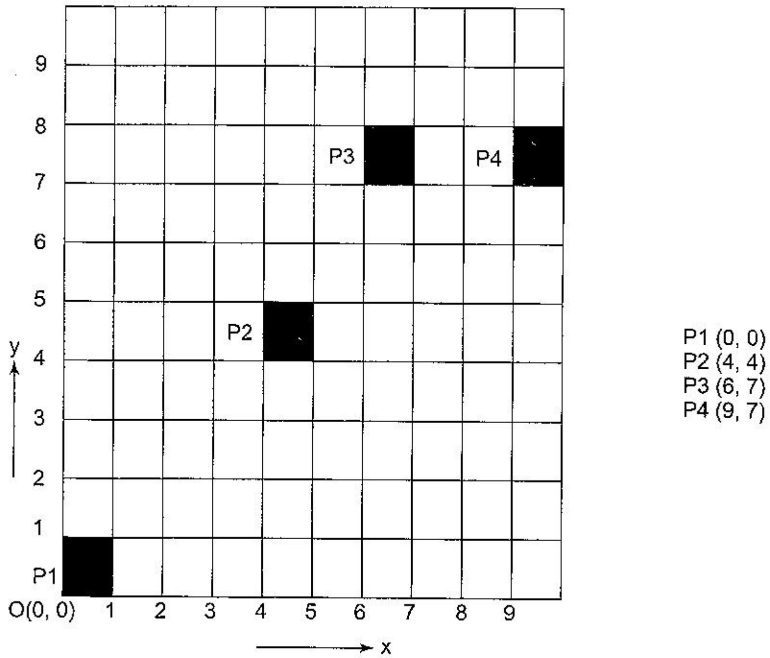


FIGURE 2.5 Grid of Pixels

Any image that is displayed on the monitor is made up of thousands of such small pixels. Each pixel has a particular color and intensity value. It is a measure of screen resolution.

Dead pixels

A dead pixel is not a common issue for monitors, however this issue can still occur. When this does occur, it is common on many monitors that an entire row or entire column of pixels to go out. Most monitor manufacturers do not have a policy or warranty for this issue and when this occurs then replace the monitor if in warranty.

2.2.3 Dot pitch

The internal surface of monitor screen is coated with red, green, and blue phosphor material that glows when struck by a stream of electrons. This coated material is arranged into an array of million of tiny cells—red, green, and blue usually called dots.

Dot pitch is the measurement of the diagonal distance between two liked-colored (red, green or blue) pixels on a display screen. It is measured in millimeter(mm). Usually monitors are available with dot pitch specification 0.25 mm to 0.40 mm. The smaller the dot pitch, the higher the resolution, sharpness and detail of the image displayed. Generally, a dot pitch of 0.31 mm will provide clear images.

2.2.4 Resolution

Image Resolution: It refers to pixel spacing i.e., the distance from one pixel to the next pixel.

Screen Resolution: It refers to number of pixels in the horizontal and vertical directions on the screen.

The information given below applies to a desktop *CRT monitor's resolution.*

Figure 2.6 shows an example of a screen running at 640 × 480 which means 640 pixels are going horizontally by 480 pixels going vertically. When increasing the resolution, the image will become smaller due to the screen displaying more pixels per inch.

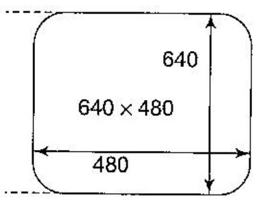


FIGURE 2.6 Screen with 640 x 480 Resolution

When setting the resolution higher you must have the needed Video RAM to support that resolution.

Minimum Resolution

Size is an important factor of the computer's running resolution. When picking the resolution, try basing it off the monitor's size for best use. Table 2.3 depicts monitors' size and their corresponding resolutions.

TABLE 2.3

Size	*Resolution*
13-inch	640 × 480
15-inch	800 × 600
17-inch	1024 × 768
21-inch	1024 × 768

Unlike the resolution on a CRT computer monitor, the LCD has a fixed amount of liquid crystal cells and can only display one set resolution defined by the LCD manufacturer. Because of this, an LCD screen which has a set resolution of 1024 × 768 can have a smaller display, however, when the screen is decreased in size it will not use the complete screen causing the image to have a black border around the image. Most new computers will have a capability of stretching this image causing the image to utilize the full screen but this degrades the display, especially noticeable on text. The size of a computer monitor is determined by going from the bottom left corner to the top right corner. However, if you have a 17" monitor, the viewable area may only be e 14.5" to 15" However, when measuring LCD panels, there is no loss of display. Generally, you will see laptop manufacturers rating the LCD in various sizes, these sizes and what they are comparable to are listed below.

TABLE 2.4

LC DD	*CRT*
13.5"	15"
14.5"–15"	17"
18"	21"

2.2.5 Bit Depth

It refers to the number of bits assigned to each pixel in the image and number of colors that can be created from those bits. In other words, it specifies number of colors that a monitor can display. One byte(8 bits) per pixel represents 2^8=256 colors for each pixels.

It is also referred to as **color depth.**

Number of bits allotted to bit depth depends upon amount of memory required in display unit as illustrated in Table 2.5.

TABLE 2.5

Video Standards	*Resolution*	*Bit Depth*	*Storage Required*	*Number of Colors*
Monochrome		1		2
CGA(Color Graphics Adapter)	320 × 200	2	16000 Byte	$2^2 = 4$
EGA(Enhanced Graphics Adapter)	640 × 350	4		$2^4 = 16$
VGA(Video Graphics Array)	640 × 480	8		$2^8 = 256$
XGA(Extended Graphics Array)	800 × 600	16		$2^{16} = 65,536$
SVGA(Super Video Graphics Array)	1280 × 1024	24		$2^{24} = 16,777,216$

Display quality is quite important to many computer users because the display is one of the most used devices in your computer system. **Dot pitch, Resolution and Bit depth** are three important parameters to measure display quality.

2.2.6 Aspect Ratio

It is the ratio of the horizontal points to the vertical points necessary to produce equal-length lines in both directions on the screen i.e.,

$$\text{Aspect ratio } (1_s) = \frac{\text{No. of horizontal points}}{\text{No. of vertical points}}$$

to produce lines of equal length in both directions.
Aspect ratio is an important parameter to measure screen size.

Aspect ratio may be less than 1 or greater than 1 depending upon screen mode, horizontal format (Landscape Mode) or vertical mode(Portrait Mode).

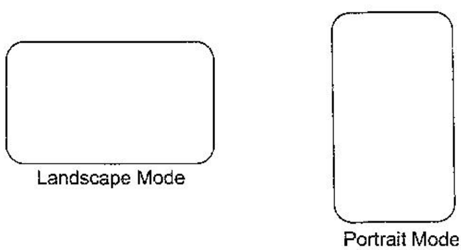


FIGURE 2.7 Screen Modes

Most computers have landscape monitors and most software is designed for that mode. Landscape monitors have aspect ratio more than 1, usually in the ratio 4:3.

DVST features :-

1. provides flicker free display and capable of displaying an unlimited number of vectors or any complex picture.

2. DVST stores the picture information as a charge distribution just behind the phosphorus coated screen. So no refreshing is required.

3. Easier to program as compared to other CRT display.

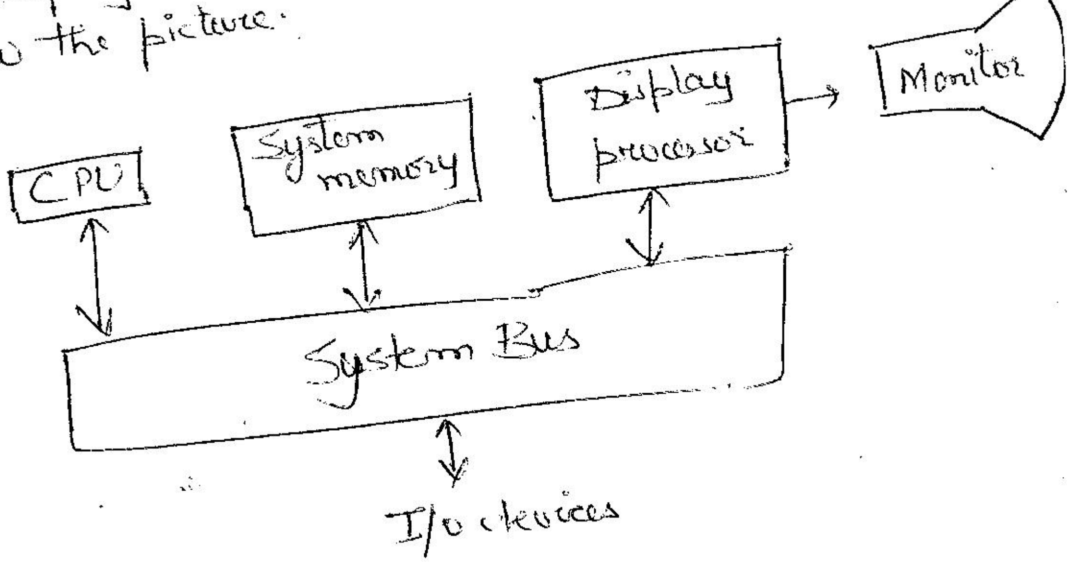
4. Dynamic motion and animation is not possible with DVST devices and cannot display color.

5. Modifying any part of the image requires redrawing the entire modified image.

- Calligraphic System :-

1. It draws one line at a time. The lines can be drawn in any arbitrary order of the display commands, that is why it is called random system.

2. The display commands are stored in refresh buffer to draw the picture.



Differences between DVST and Refresh CRT

Unlike CRT, DVST has storage tube and this tube retains the picture until :: erased. Thus no refreshing is necessary, complex pictures can be displayec very high resolutions without flicker.

Performance of DVST is somewhat inferior to refresh CRT.

DVST has no refresh buffer thus to eliminate a picture section, the en screen must be erased and to modified.

DVST behaves like a CRT with an extremely long persistence phosphor.

DVS Tcreates bright picture.

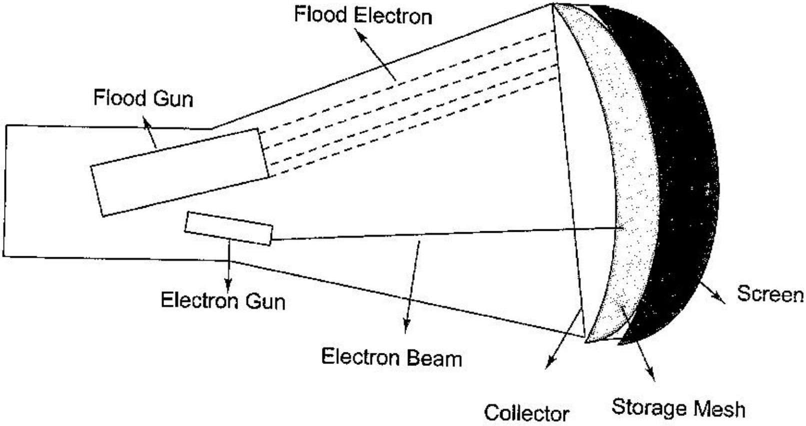


FIGURE 2.26 Direct View Storage Tube

Types of CRT display devices

- DVST (Direct View Storage Tube) [Two gun: Primary, flood]
- Calligraphic (Vector display) [Animation is possible with segmentation]
- Raster scan [Home Television Sets] [each screen point has values]

Lecture - 2

Raster Scan Display System:-

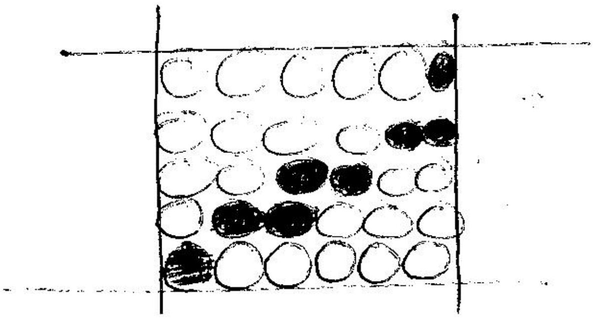
- In this display system, electron beam scans each row of the screen one by one from top to bottom. Each screen point on each row has intensity value either 0 or 1. This intensity value is stored in refresh buffer or frame buffer.

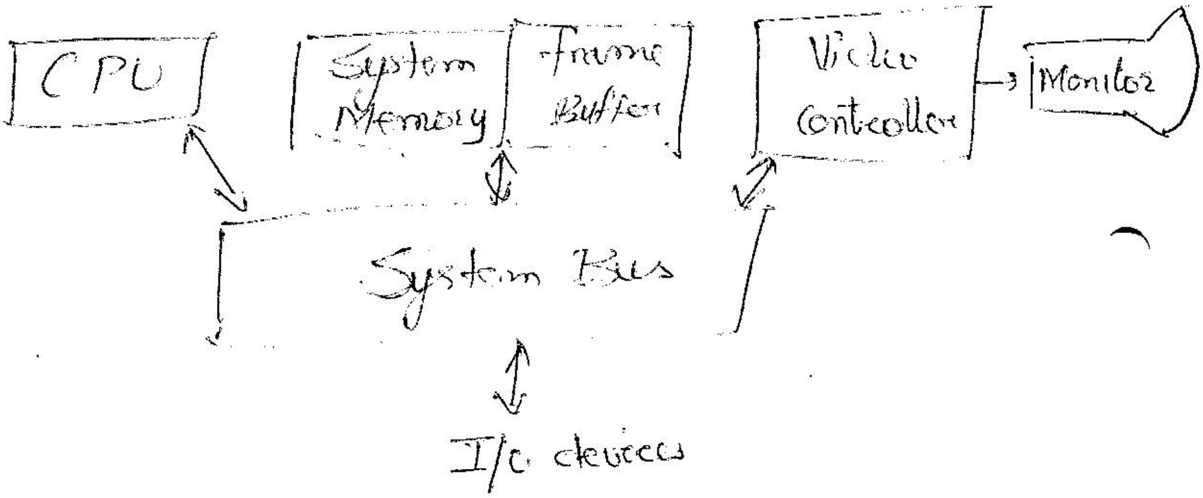
- Intensity range of the raster system depends on the capability of the system. B/W '1'→ white '0'→ Black.
  A High quality system has to display color and intensity variations, more bits can be used. (upto 24 bits/pixel)

  Frame Buffer → Bitmap (B/W), Pixmap (Color)

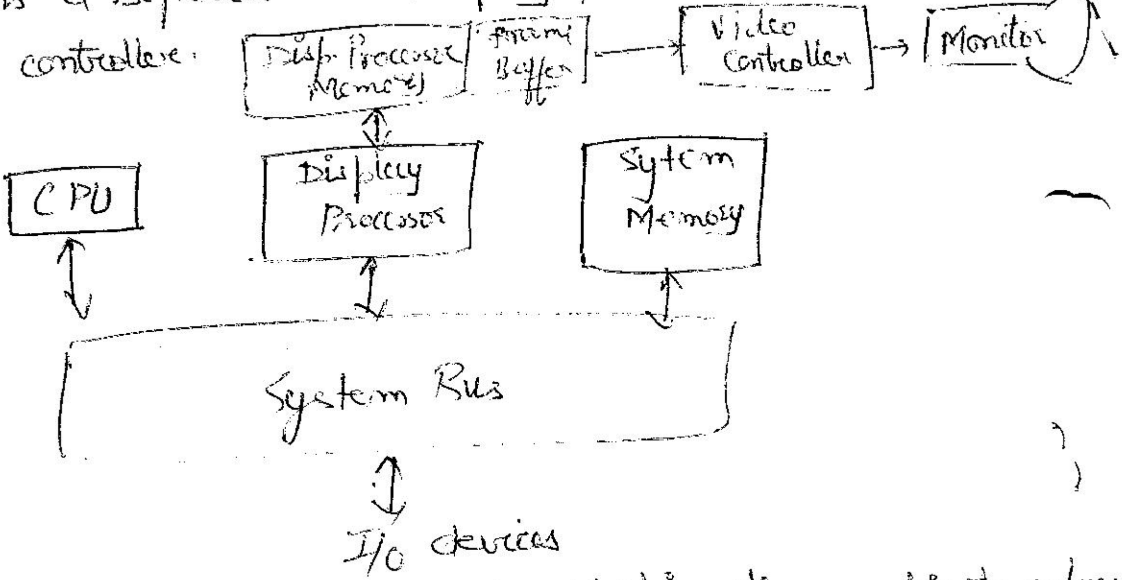
  Refresh Rate → 60-80 frames/second.

- Horizontal retrace :- After scanning one row, when we return to the left of the screen for scanning next row.
- Vertical retrace :- After refreshing each scan line we move to the left corner of the screen, to again start the refreshing process.
- Raster system has lower resolution as compared to random system.
- Raster system produces jagged lines (aliasing) because points are plotted as discrete point sets.

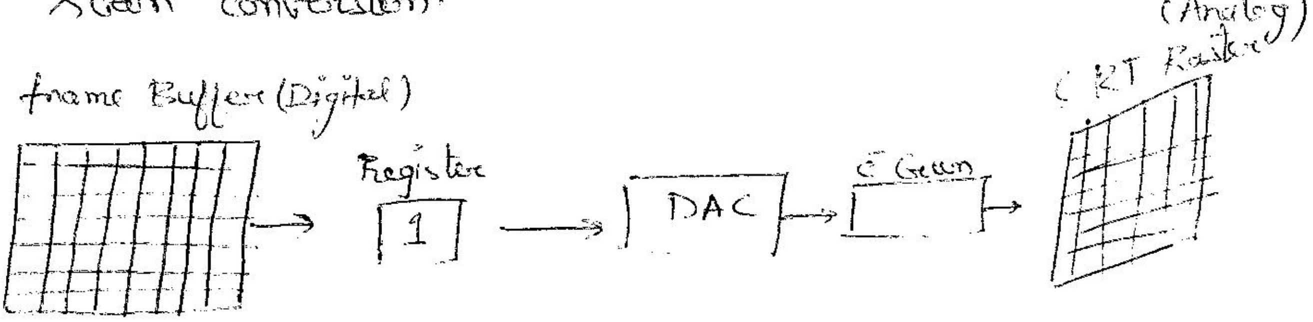




- There is another way to organize the raster scan system. It contains a separate Display processor, also called a graphics controller.



- The role of display processor is to digitize the coordinate values in an application program into pixel-intensity values for storage in the frame buffer. The process of digitization is called scan conversion.



2^N-1 represents the full intensity level. This is converted into an analog voltage between 0 and the maximum voltage of the electron gun by the DAC, resulting in 2^N intensity levels or colors.

An increase in the number of intensity levels can be achieved by using a lookup table which is already discussed in chapter 1. After reading the bit planes in the frame buffer, the resulting number is used as an index into the lookup table. If there are N bit planes then the lookup table is a $2^N \times W$ sized table, where W is the number of columns. Thus 2^W colors are possible but only 2^N different intensities are available at one time (see Fig. 2.4).

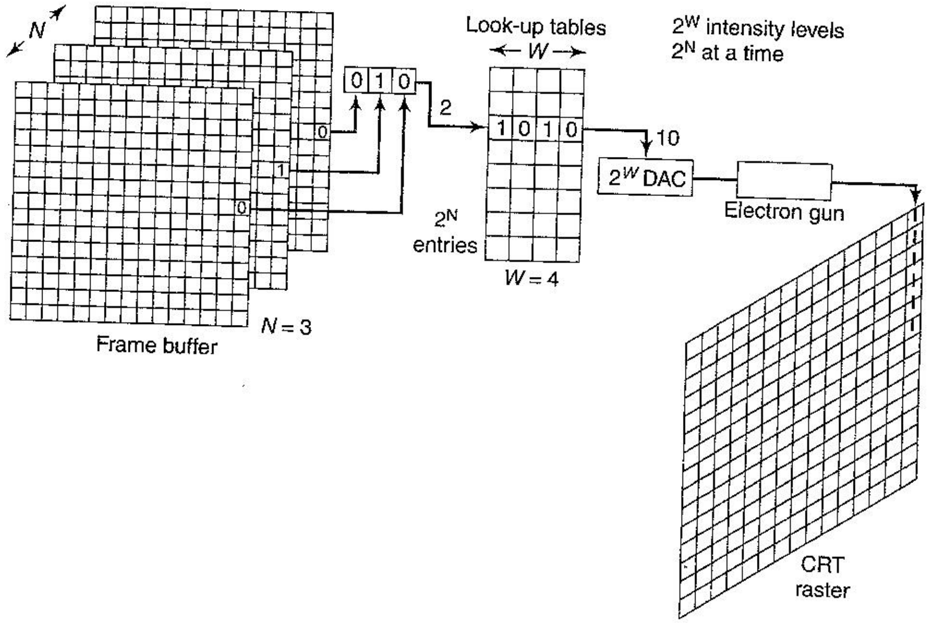


Fig. 2.4 *An N-bit-plane Gray Level Frame Buffer, with a W-bit-wide Lookup Table*

A simple color frame buffer is implemented with three bit planes because there are three primary colors as one bit plane for each of the three primary colors is used. Each bit plane drives one color gun for each primary color, thus yielding 8 colors.

Additional bit planes may be used for each of the three-color guns. A 24-bit plane frame buffer with 8 bit planes per color gives 2^{24} possible colors (see Fig. 2.5). 2^8 shades of red, green or blue are provided. The number of colors can further be extended by using the lookup table for each of the groups of bit planes of red, green and blue.

The raster refresh displays are further improved to some of the displays like flat panel display, liquid crystal display, plasma display and electroluminescent display.

2.3 INTERACTIVE DEVICES

Apart from the keyboard, there are many interactive devices. However, a few of them, namely, tablet, light pen, joystick, mouse, control dial, button, data glove, and touch screen are discussed. These physical devices are used to implement the logical interactive devices, which will be discussed in the next section.

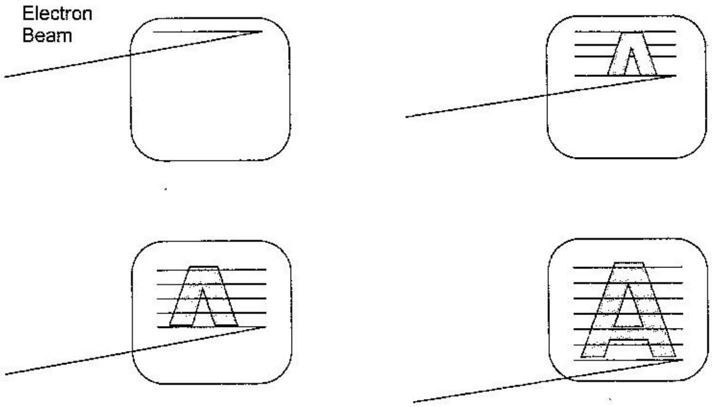


FIGURE 2.20 Raster Scan Display

Home television sets and printers are examples of using raster scan methods.

Interlacing

On some raster scan systems each frame is displayed in two passes using an interlaced refresh procedure. In the first pass, the beam sweeps (odd scan lines) across every other scan line from top to bottom. Then after the vertical re-trace, the beam sweeps out the remaining (even scan lines). Interlacing of the scan lines in this way allows us to see the entire screen displayed in one-half the time it would have taken to sweep across all the scan lines at once from top to bottom. Interlacing is primarily used with slower refreshing rates.

Suppose we have refresh rate 30 Hz for non-interlaced display, some flicker is noticeable. But with interlacing, each of the two passes can be accomplished in 1/60th of a second, which brings the refresh rate nearer to 60 frames per second as illustrated in Fig. 2.21(a) and 2.21(b). This is an effective technique for avoiding flicker, providing that adjacent scan lines contain similar display information.

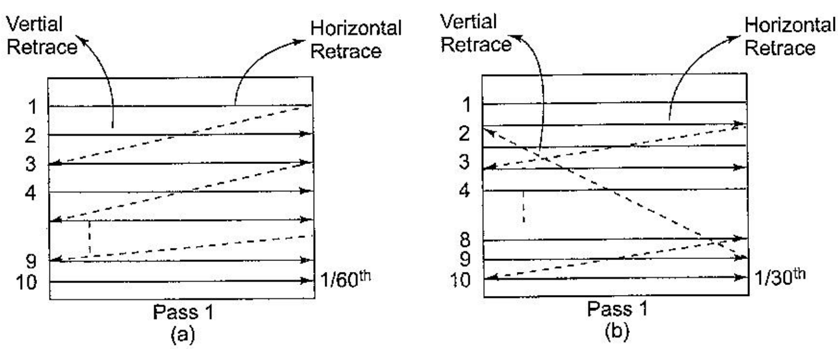


FIGURE 2.21 Interlacing scan lines on a raster scan display. First, all points on the odd-numbered scan lines are displayed (Pass 1); then all points along the even-numbered lines are displayed (Pass 2).

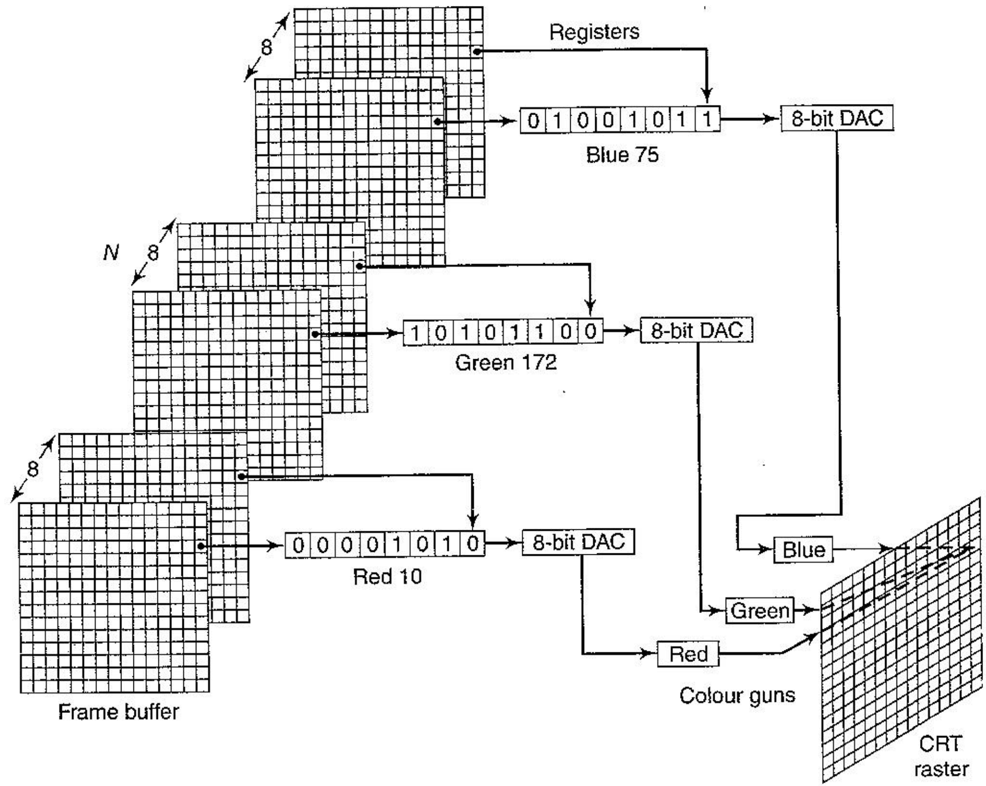


Fig. 2.5 *A 24-bit Plane Frame Buffer with 8 Bit Planes per Color gives 2^{24} Possible Colors*