CHAPTER – 2

Hardware Concepts

2.1 Input Devices

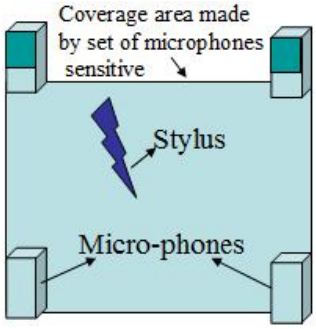
Input device are used to feed data or information into a computer system. They are usually used to provide input to the computer upon whose reaction, outputs are generated. The various type of input devices are keyboard, mouse, light pens, touch panels etc.

1. Tablet

A tablet is a digitizer which is used to scan over an object and to put a set of discrete coordinate positions. These positions can then be joined with straight line segments to approximate the shape of the original object. A tablet digitizes an object detecting the position of a movable stylus (pencil-shaped device) or puck (like mouse with cross hairs for sighting positions) held in the user's hand. A tablet is flat surface and its size varies from about 6 by 6 inches up to 48 by 72 inches or more. The accuracy of the tablets usually falls below 0.2 mm.

There are three types of tablets

- **Electric tablet:** A grid of wires on ¼ to ½ inch centers is embedded in the tablet surface, and electromagnetic signals generated by electrical pulses applied in sequence to the wires in the grid induced an electrical signal in a wire coil in the stylus (or puck). The strength of the signal induced by each pulse is used to determine roughly how far the stylus is from the tablet. They cannot digitize the bulky objects because the movement of stylus over the object cannot sense by the electric tablet surface.



- **Sonic tablet:** The sonic tablet uses sound waves to couple the stylus to microphones positioned on the periphery of the digitizing area. An electrical spark at the tip of the stylus creates sound bursts. The position of the stylus or the coordinate values is calculated using the delay between when spark occurs and when its sound arrives at each microphone. They can digitize the bulky objects because the position point out by the stylus by generating the sound wave can easily encounter by the system with the help of microphones.

- **Resistive tablet:** The tablet is transparent and flexible with a thin layer of conducting material. When a battery-powered stylus is activated at certain position, it emits high-frequency radio signals which induce the radio signals on the conducting layer. The strength of the signal received at the edges of the tablet is used to calculate the position of the stylus. They can also able to digitize some object of screen.

2. Touch Panel

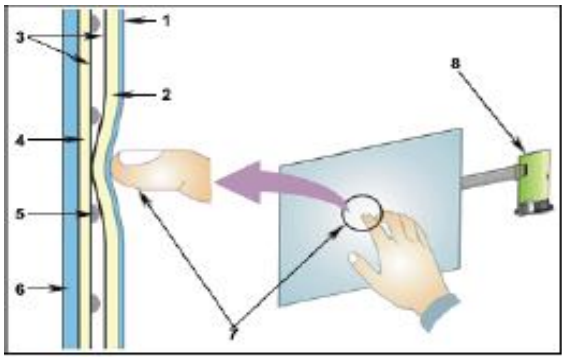
A touch panel is an input device that accepts user input by means of a touch sensitive screen directly with a finger to move the cursor around the screen or to select the icons. Because of their compact nature and ease-of-use, touch panels are typically deployed for user interfaces in automation systems, such as high-end residential and industrial control.

1. Polyester Film
2. Upper Resistive Circuit Layer

3. Conductive ITO (Transparent Metal Coating)
4. Lower Resistive Circuit Layer
5. Insulating Dots
6. Glass/Acrylic Substrate
7. Touching the overlay surface causes (2) Upper Resistive Circuit Layer to contact the (4) Lower Resistive Circuit Layer, producing a circuit switch from the activated area.
8. The touch screen controller gets the alternating voltages between the (7) two circuit layers and converts them into the digital X and Y coordinates of the activated area.

Input Devices: Touch Screens

plasma panels with touch screens



Followings are mostly used touch panels:

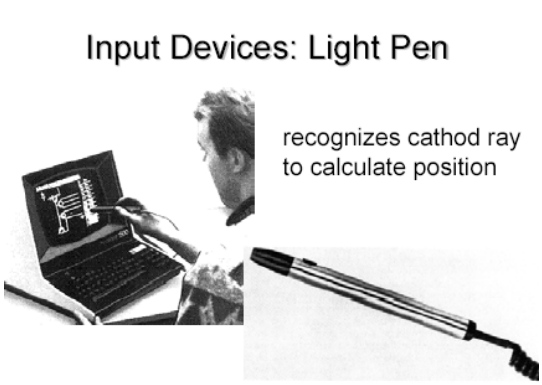
- **Optical touch panel:** It uses a series of infrared light emitting diodes (LED) along one vertical edge and along one horizontal edge of the panel. The opposite vertical and horizontal edges contain photo detectors to form a grid of invisible infrared light beams over the display area. Touching the screen breaks one or two vertical and horizontal light beams, thereby indicating the finger's position. This is low resolution panel, which offers 10 to 50 positions in each direction.

- **Sonic panel:** Burst of high-frequency sound waves traveling alternately horizontally and vertically generated at the edge of the panel. Touching the screen causes part of each wave to reflected back to its source. The screen position at the point of contact is then calculated using the time elapsed between when the wave is emitted and when it arrives back at source. This is a high-resolution touch pane having about 500 positions in each direction.

- **Electric touch panel:** It consists of slightly separated two transparent plates one coated with a thin layer conducting material and the other with resistive material. When the panel is touched with finger, the two plates are forced to touch at the point of contact thereby creating the voltage drop across the resistive plate which is then used to calculate the co-ordinate of the touched position. The resolution of this panel is similar to that of sonic touch panel.

3. Light pen

It is a pencil-shaped device to determine the coordinate of a point on the screen (i.e. digitizer). In raster display, Y is set at Ymax and X changes from 0 to Xmax the first scanning line. For second line, Y decreases by one and X again changes from 0 to Xmax, and so on. When the activated light pen "sees" a burst of light at certain position as the electron beam hits the phosphor coating at that position, it generates an electric pulse, which is used to save the video controller's X and Y registers and interrupt the computer. By reading the saved values the graphics package can determine the coordinates of the positions seen by the light pen. Because of the following drawbacks the light pens are not popular.



- Light pen ***obscures*** or hides the screen images as it is pointed to the required spot.
- Prolong use of it can cause ***arm fatigue***.
- It cannot report the coordinates of a point that is completely black.
- It gives sometimes false reading due to background lighting in room.

4. Keyboard

A keyboard creates a code such as ASCII uniquely corresponding to a pressed key (i.e. work on ***Hall's effect***). It usually consists of alphanumeric key, function keys, cursor-control keys, and separate numeric pad.

5. Mouse

A mouse is a small hand held device used to position the cursor on the screen. Following are the mice, which are mostly used in computer graphics.

- **Mechanical mouse:** It moves the curser position on the screen according as the moment of the roller in the base of this mechanical mouse.
- **Optical mouse:** A LED in the bottom of the mouse directs a beam of light down onto the pad from which it is reflected and sensed by the detectors.

6. Barcode reader

A barcode reader (or barcode scanner) is an electronic device for reading printed barcodes. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain ***decoder circuitry*** analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port. The barcode reader can be categories as:

- **Pen-type readers**
  - Pen-type readers consist of a light source and a photodiode that are placed next to each other in the tip of a pen or wand.
  - To read a bar code, the tip of the pen moves across the bars in a steady motion.
  - The photodiode measures the intensity of the light reflected back from the light source and generates a waveform that is used to measure the widths of the bars and spaces in the bar code.
  - Dark bars in the bar code absorb light and white spaces reflect light so that the voltage waveform generated by the photo diode is a representation of the bar and space pattern in the bar code.
  - This waveform is decoded by the scanner in a manner similar to the way Morse code dots and dashes are decoded.

- **Laser scanners**
  - Laser scanners work the same way as pen type readers except that they use a laser beam as the light source and typically employ either a reciprocating mirror or a rotating prism to scan the laser beam back and forth across the bar code.
  - As with the pen type reader, a photodiode is used to measure the intensity of the light reflected back from the bar code.

7. **Data Glove**

A data glove is an interactive device, resembling a glove worn on the hand, which facilitates physical sensing and fine-motion control in ***robotics*** and ***virtual reality***. Data gloves are one of several types of electromechanical devices used in ***haptic applications***. Tactile sensing involves simulation of the sense of human touch and includes the ability to perceive ***pressure, linear force, torque, temperature,*** and ***surface texture.***

2.2 Output Devices

All the **output devices** can be categorized as hardcopy and softcopy devices.

- **Hard copy devices** are those that give the output in the tangible form. Printers and Plotters are two common hard copy devices.
- **Soft copy devices** give output in the intangible form or the virtual form, e.g. something displayed on a screen. All the computer monitors are covered under this category.

A. Hardcopy Devices

Printers

All the printers irrespective of the technology used can be categorized as:

- **Impact printers:** There is a direct contact between the printing head and the paper on which the print is produced. They work by striking a head or a needle against an inked ribbon which leaves a mark on the paper. These printers produce a lot of noise when printing, because of the head striking the paper. Examples are ***Dot Matrix, Daisy Wheel*** and ***Line printers***.
- **Non-impact printers:** the printing head never comes in direct contact with the paper. These printers work by spraying ink on the paper. Electrostatic or electromagnetic charge is used in these printers. Examples are ***Ink-Jet*** and ***Laser*** printers.

Plotter

The plotter is a computer printer for printing vector graphics. Plotters differ from printers in that they draw lines using a pen. As a result, they can produce continuous lines, whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor plotters use different-colored pens to draw different colors. Thus, plotters are considerably more expensive than printers. The various type of plotter is: Drum plotter, Flatbed plotter, Electrostatic plotter etc.

B. Display Devices

The devices which can give the user interface of the inputted data are the display devices. In the case of computer, the monitor is most common display device that can be categories as the Cathode Ray Tube (CRT) monitor and the flat panel monitor. To display the image, computers have some assigned memory called the frame buffer. The graphic cards also have the memory buffer and the graphics processors so that it can increase the display strength of the computer graphics.

- ***Pixel:*** Graphic displays are like very large ***dot matrices***. Each dot in a graphic display is called ***picture element***, *pixel* or ***pel***. The capabilities of a graphic display depend on number of pixels horizontally and vertically.
- ***Dpi*** =Dot per inch
- ***Ppi*** = Point per inch

Typical Term for Display Devices

- **Fluorescence/ Phosphorescence**

  When the electron beam strikes the phosphor coated screen of the CRT, the individual electrons are moving with kinetic energy proportional to the accelerating voltage. Some of this energy is dissipated as heat, but rest is transferred to the electrons of phosphor atoms making jump to higher quantum energy levels. In returning to their previous quantum levels, these excited electrons give up their extra energy in the form of light of different frequencies i.e. colored light, predicted by the quantum theory.

  - ***Phosphorescence*** is the light given off by the return of the relatively more stable excited electrons to their unexcited state, once the electron beam excitation is removed.
  - Most of the phosphors relax back to the ground state by emitting a photon of light which is called ***fluorescence***

- **Persistence**

  A phosphor's persistence is the time for the emitted light to decay to 10 % of the initial intensity. The persistence may be varied with different phosphors. The phosphors used for graphics display usually have persistence of 10 to 60 microseconds. A phosphor with low persistence is useful for animation; a high persistence phosphor is useful for high complex static picture.

- **Refresh Rate**

  The refresh rate is the number of times per second the image is redrawn to give a feeling of un-flickering pictures and is usually 50 per second. The refresh rate above which a picture stops flickering and fuses into a steady image is called the ***critical fusion frequency (CFF)***. The factors affecting the CFF are persistence, image intensity, room light, wave length of light & observer.

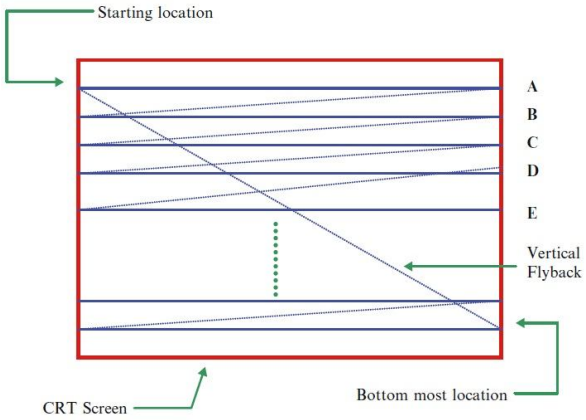
- **Resolution**

  Resolution is defined as the maximum number of points that can be displayed horizontally and vertically without overlap on the display device. Factors affecting the resolution are the intensity & spot profile.

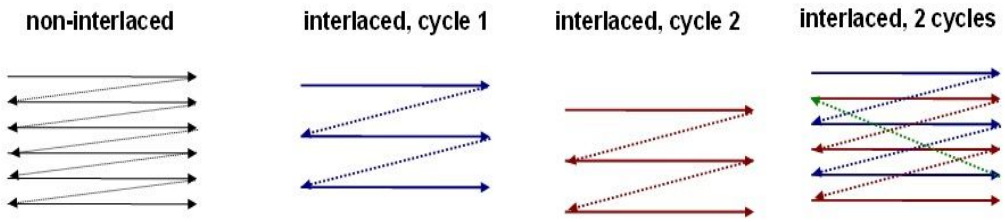
- **Aspect ratio**

  The ratio of vertical points to horizontal point necessary to produce equal length line in both directions on screen (as monitor is rectangular not the square) is called aspect ratio. An aspect ratio of ¾ means that a vertical line is plotted with 3 points has the same length as horizontal line plotted with 4 points. Generally, the aspect ratio is not one.

- **Retrace procedure**
  At the end of each scan line in raster scan display, the electron beam returns to the left side of the screen to begin displaying the next scan line. The return to the left of the screen, after refreshing each scan line is called the ***horizontal retrace*** of the electron beam. And at the end of each frame the electron beam returns to the top left corner of the screen to begin the next frame which is called ***vertical retrace***.



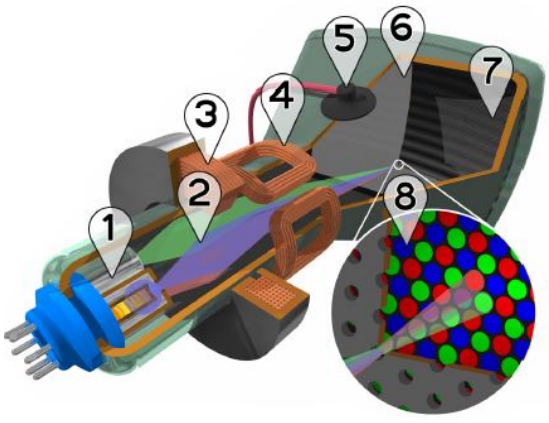
- **Interlaced refresh procedure**
  On some raster scan systems each frame is displayed in two passes using an *interlaced refresh procedure* so that the whole picture should displaced in half time. Here, the first scan does the ***even lines*** 0, 2, 4,... then the second scan does the ***odd lines*** 1, 3, 5,.... Interlacing is primarily used with slower refreshing rates to avoid the flickering. To show the animation, we have to move 24-frame per second (fps).



A. Color CRT

The **cathode ray tube (CRT)** technology was first used for computer displays, video monitors, televisions, radar displays and oscilloscopes. The CRT is an Evacuated gas tube that uses the filament to produce the electron beams which are focused in proper position of phosphorous coated screen by the help of magnetic focusing & deflection coils. Phosphors are ***organic compounds*** characterized by their persistence and their color (blue, red, green). A cathode ray tube (CRT) contains these basic parts:

1. Electron guns
2. Electron beams
3. Focusing coils
4. Deflection coils
5. Anode connection
6. Mask for separating beams for red, green, and blue part of displayed image
7. Phosphor layer with red, green, and blue zones
8. Close-up of the phosphor-coated inner side of the screen



* CRTs, or ***video monitors***, are the most common output device on computers today that uses the phosphors coated screen. Phosphors are characterized by color (RGB) and persistence.
* After the generation of electrons of weaker negative charge by heating the filament, it is focused to accelerate it by the repulsion of the inner cylinder walls in just the way that water is speeds up when its flow though a smaller diameter pipe.

* Then, the electron beam is deflected at proper position by the help of two set of plates of opposite charge, one positive the other negative. The first set displaces the beam up and down, and the second displaces the beam left and right. This helps us to focus the electron beam in proper position.
* The user can vary the voltage on the control grid to attenuate the electron flow. The electron beam causes the phosphor's atoms to move into higher energy state. The atoms give off energy as light when they return to their stable state i.e. glow & decay operation occurs & hence we need to refresh the screen continuously.
* A refresh rate of 50 - 60 Hz is usually sufficient to prevent flicker, but some systems refresh at even higher rates such as 72-76 Hz.

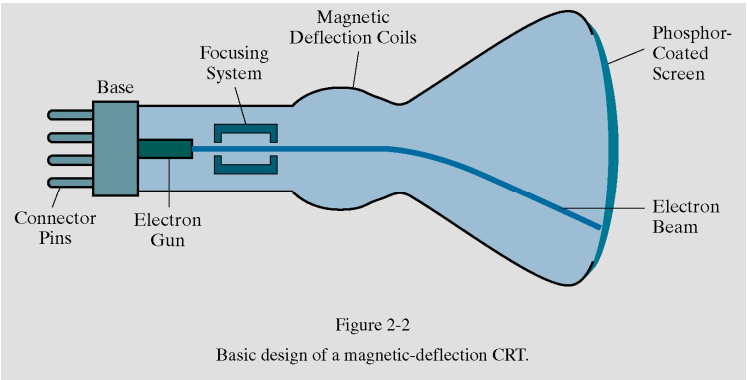
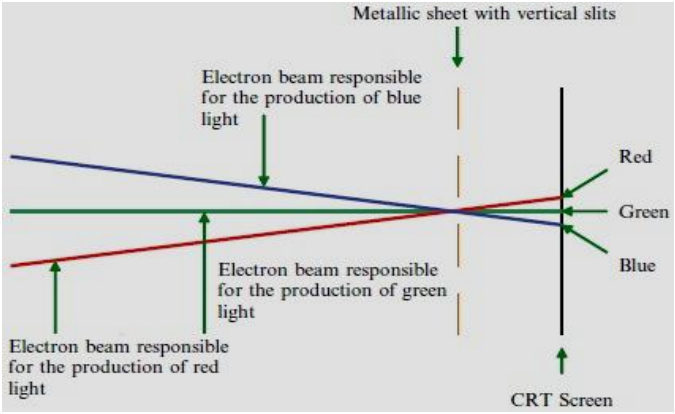


Figure 2-2
Basic design of a magnetic-deflection CRT.



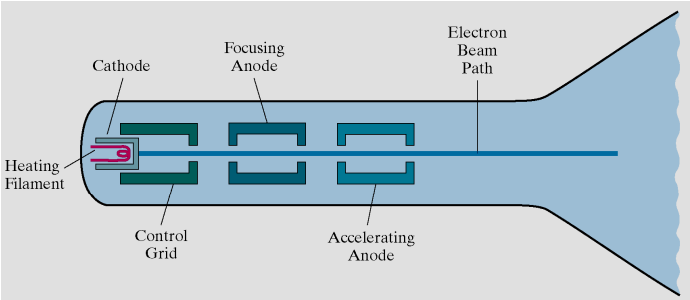


Figure 2-3
Operation of an electron gun with an accelerating anode.

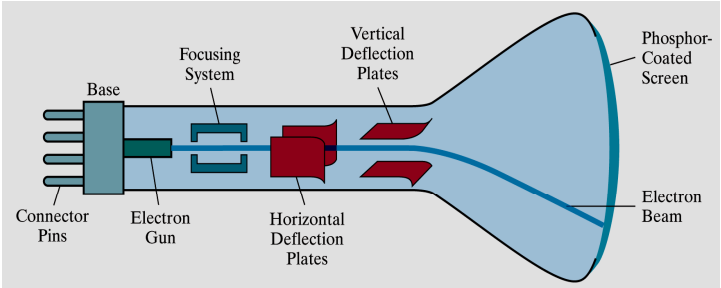


Figure 2-4
Electrostatic deflection of the electron beam in a CRT.

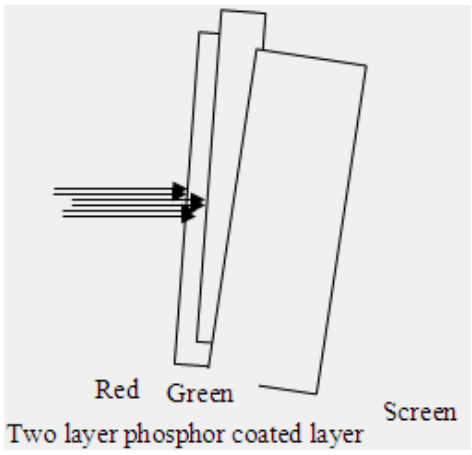
Methods for Color CRT

Two Methods are used in Color CRT for the raster display method

a. Beam Penetration Method

The beam penetration method is for the random scan monitor display where two different layers of phosphor coating are used, Red (outer) and Green (inner) coated on the CRT screen. The display of color depends on the depth of penetration of the electron beam into the phosphor layers. Screen color is controlled by the beam acceleration voltage. In this method, only four colors possible and hence the poor picture quality

- A beam of slow electrons excites only the outer ***red*** layer
- A beam of very fast electrons penetrates thru the red phosphor and excites the inner ***green*** layer.
- Intermediate is a combination of red and green so two additional colors orange and yellow color.
  - When quantity of red is more than green then color appears as ***orange***
  - When quantity of green is more than red then color appears as ***yellow***

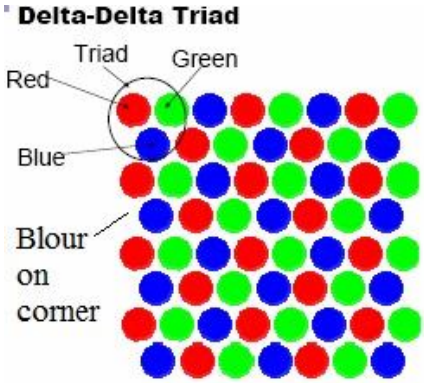


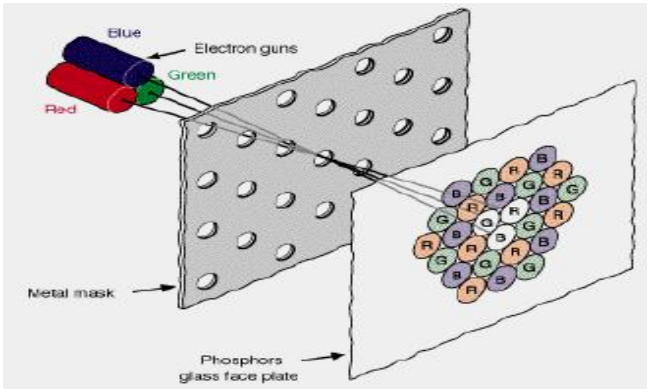
b. Shadow Mask Method

Shadow is a perforated *metal sheet* that ensures that the electron beam hits only the correctly colored phosphor dots and does not illuminate more than one dot. Essentially, the shadow mask "masks" the electron beam, thereby forming a smaller and more rounded point that can hit individual phosphor dots. The shadow mask absorbs electrons that are directed at the wrong color phosphor.

i. Shadow Mask (Delta-Delta CRT)

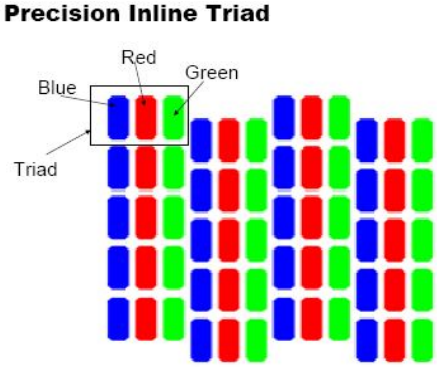
- Normally for Raster Scan System
- Inner side of viewing has several groups of Electron gun closely spaced red, green and blue phosphor dots called ***triad*** in delta fashion
- Thin metal plate is perforated with many holes near to inner surface called ***shadow mask***
- Shadow mask mounted in such a way that *each hole is aligned with respective triad*
- Triad so small that, it is perceived as a mixture of color.

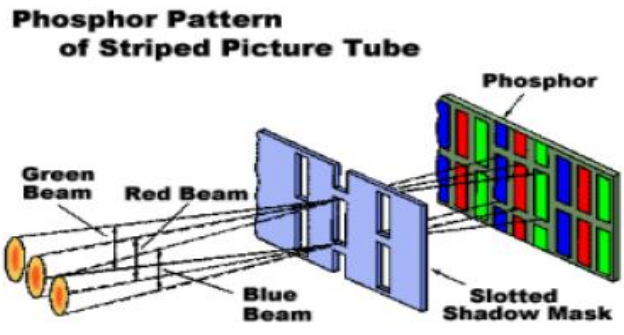




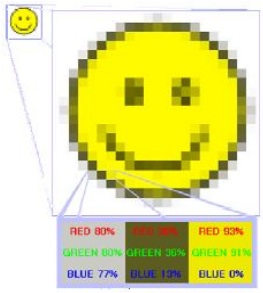
ii. Shadow Mask (Precision Inline CRT)

- Eliminates drawback of delta-delta CRT at the cost of slight reduction of images sharpness
- Normally 1000 scan lines
- Distance between centers of adjacent ***triads*** is called ***pitch.***
- In very high resolution pitch=0.21mm (0.61mm for home TV)
- Diameter of a electron beam is set at 1.75 * pitch (at which 50% of max)
- But small pitch is difficult to manufacture due to small triads too many holes in the shadow mask
- Also shadow mask decreases brightness only 20% electron beam hit the phosphorous
- No. of electron increased by increasing beam current (but focusing difficult, generate more heat & mask wrapping)



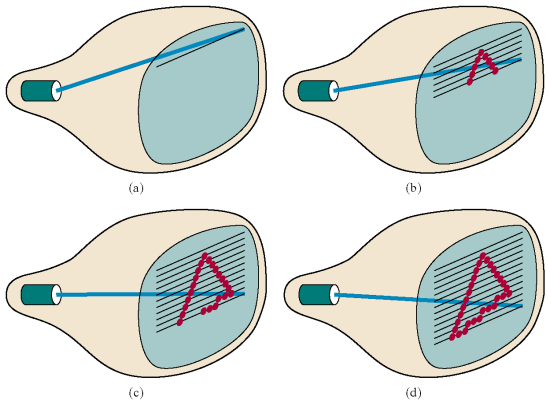


2.3 Raster Graphics



* A **raster graphics** image, **digital image**, or **bitmap**, is a data file or structure representing a generally rectangular grid of pixels, or points of color, on a computer monitor, paper, or other display device.
* The color of *each pixel is individually defined*; images in the RGB color space, for instance, often consist of colored pixels defined by three bytes—one byte each for red, green and blue.
* Here, the images are loaded on memory called the ***frame buffer*** before they display on the monitor.
* Less colorful images require less information per pixel; for example, an image with only black and white pixels requires only a single bit for each pixel.
* Raster graphics are distinguished from vector graphics in that vector graphics represent an image through the use of geometric objects such as curves and polygons.

2.3.1 Raster Display



* A raster display device is a large matrix of discrete cells or dots, each of which can be made bright to show the image on the screen.
* Our Computer Televisions uses raster display where the scanning of the pixel is done one row (scan line or raster line) at a time from the top-left of the screen to the bottom-right, even if there is change on the single pixel, in regular time interval as shown in figure.
* Here, we add a large continuous piece of special memory, called the ***frame buffer***, to store the intensity values (define shading & coloring) of each pixel and this is mapped on the screen using DAC.
* Frame buffer is a digital device but raster CRT is an analog device so DAC (Digital to Analog Converter) is required for reading from frame buffer and displaying on raster CRT.
* The ***bit plane*** is the minimum amount of memory for the pixel representation. In this memory, the bits are placed in continuous fashion as array to place the bits in matrix order. When there is bit-1, the electron gun strikes for one pixel & when bit-0, then nothing will happen. The different intensity level can be described by the number of bit planes.
* The process of digitizing the picture definition given in an application program into a set of pixel intensity values for storage in the frame buffer is called ***scan conversion.***

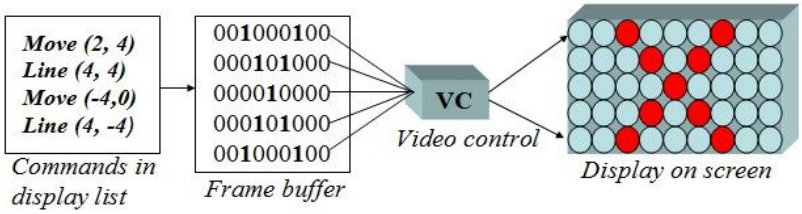


Fig. Raster display method on CRT monitor

* The ***display processor*** produces the raster image in the frame buffer from the commands, called scan conversation.
* The ***video controller*** moves the beam row wise across the pixels setting it on and off according to the content of the frame buffer
* The display must be refreshed to avoid flickering (raster image redisplayed 30 to 60 times per second)

2.3.2 Raster Display Technology

* When a particular command is called by the application program the graphics subroutine package sets the appropriate pixels in the *frame buffer*.
* The *video controller* then cycles thru the frame buffer, one scan line at a time, typically 50 times per second. It brings a value of each pixel contained in the buffer and uses it to control the intensity of the CRT electron beam.

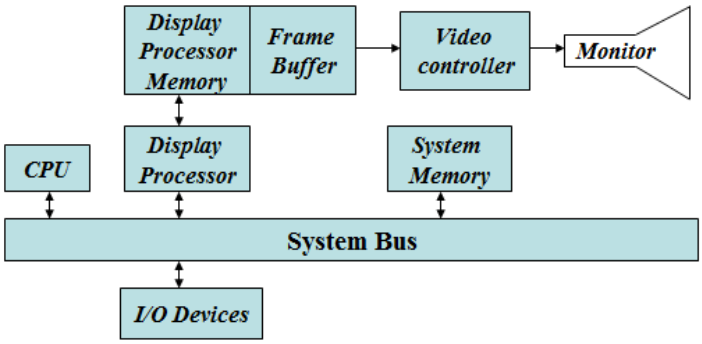


*Fig. **Architecture of Raster display system with display processor***

* So there exists a one to one relationship between the pixel in the frame buffer and that on the CRT screen
* 640 pixels by 480 lines is an example of *medium resolution* raster display & 1600 by 1200 is a *high resolution* one.

Advantages

- Ability to fill areas with solid color or patter
- Refreshing independent of the complexity of the image
- If interlaced refresh procedure is used, it draw picture quickly
- Can be used for intensity calculation and support large number of color combination.
- Can be used in any resolution, i.e., aspect ratio can be maintained easily.

Color Depth	Number of Displayed Colors	Bytes of Storage Per Pixel	Common Name for Color Depth
4-Bit	16	0.5	Standard VGA
8-Bit	256	1.0	256-Color Mode
16-Bit	65,536	2.0	High Color
24-Bit	16,777,216	3.0	True Color

Limitations

- Require special algorithm to move a pixels
- The "***stair case effect***" is unavoidable. Since the image are stores on the basis of pixel on the grid like structure so on making the small image more large, we seems the stair like image boundary of pixel. This is happen because we cannot draw the image on the half area of grid.
- To refresh a single pixel, it has to scan all frame buffers from top to bottom so is time consuming compared to the vector scan technology.
- Require more memory space (to increase frame buffer size)
- Works only with high speed display processor.

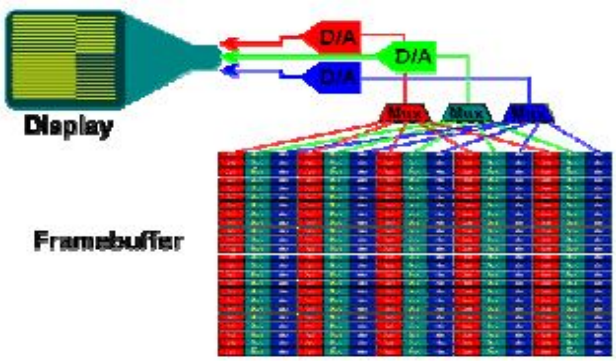
2.3.3 Frame Buffer

* Frame buffer (bit map) is a large continuous piece of memory that stores the color values of each pixel & hence the video controller connected to it, map these pixel intensity value one by one on the screen.
* Color values are commonly stored in 1-bit monochrome, 4-bit palletized, 8-bit palletized, 16-bit high color and 24-bit true color formats.
* An additional alpha channel is sometimes used to retain information about pixel transparency.

* The total amount of the memory required to drive the frame buffer is dependent on the resolution of the output signal, as well as the color depth and palette size.

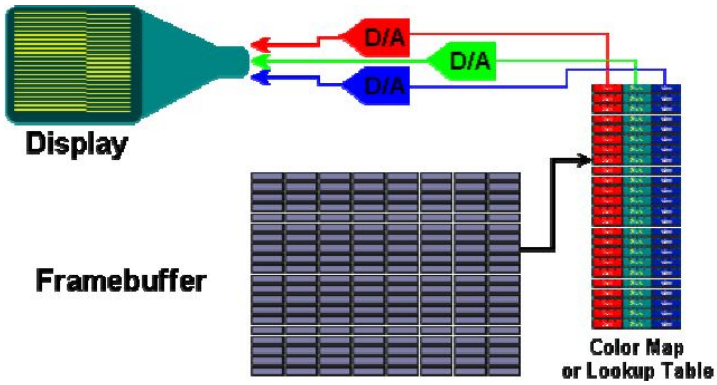
Frame Buffer Architecture of Raster Displays

- Each pixel requires at least 3 bytes. One byte for each primary color.
- Sometimes combined with a look-up table per primary
- Each pixel can be one of 2^{24} colors = 16777216 colors.



Frame Buffer Architecture of Indexed-Color

- Each pixel uses one byte
- Each byte is an index into a color map
- If the color map is not updated synchronously then *Color-map flashing* may occur.
- Color-map Animations
- Each pixel may be one of 2^{24} colors, but only 256 color be displayed at a time



Simple color frame buffer

- Three bit planes required one for each primary color. Each bit plane drives individual color gun for each 3 colors. These 3 colors are combined at CRT to yield 8 different colors.
- Each RGB electron beam being able to be set at one of 256 intensity levels.
- Total color depth of 24 bits per pixel, referred to as a true color system.
- Color and intensity are big topics in CRT design.

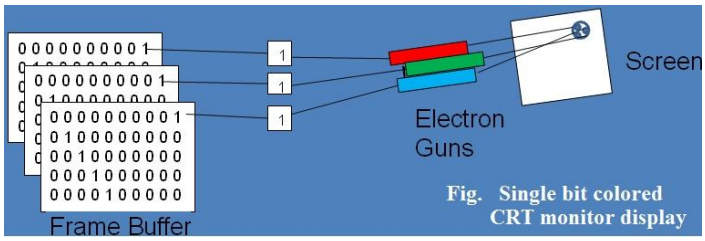
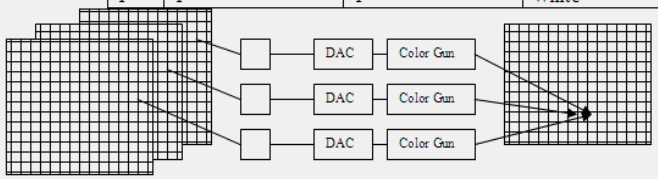


Fig. Single bit colored CRT monitor display

RED	GREEN	BLUE	Color
0	0	0	Black
1	0	0	Red
0	1	0	Green
0	0	1	Blue
1	1	0	Yellow
0	1	1	Cyan
1	0	1	Magenta
1	1	1	White



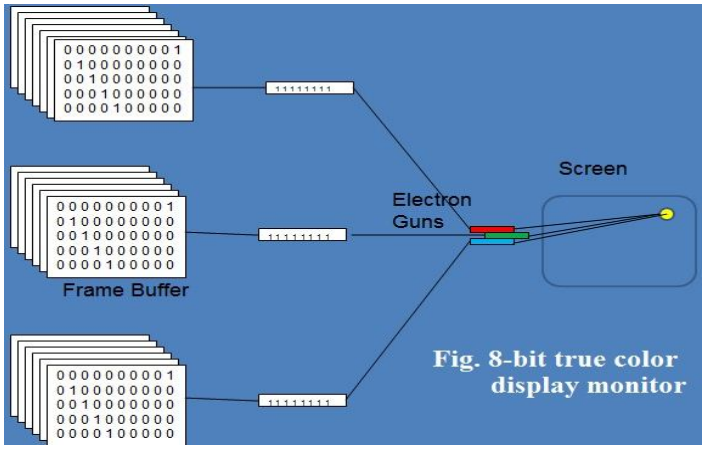


Fig. 8-bit true color display monitor

- **Numerical-1**: If a pixel is accessed from the frame buffer with an average access time of 300ns then will this rate produce an un-flickering effect for the screen size: 640 x 480.

  Solution

  The size of the screen = 640 x 480
  The average access time of one pixel = 300ns
  Thus, the time required for total pixel to show the image on the full screen = 640 x 480 x 300ns
  = 640 x 480 x 300 x10^{-9} sec = 0.09216 sec

  Now, The frequency of cycle for image = 1/ 0.09216 sec = 10.86 frame / sec (since, f = 1/t)

  As we know that the minimum number of frame on monitor must be more than 60fps for the un-flicker image display. Hence, we conclude that this monitor has fickleness.

- **Numerical-2:** If the total intensity achievable for a pixel is 256 and the screen resolution is 640 x 480. What will be the size of the frame buffer?

  Solution

  There is only one frame buffer with pixel intensity 256 = 2^8
  Thus, the number of bits required for the screen of size 640 x 480 x 8 = 2457600 bits = 300 KB.

- **Numerical-3:** What is the time required to display a pixel on the monitor of size 1024 X 768 with refresh rate 60 Hz.

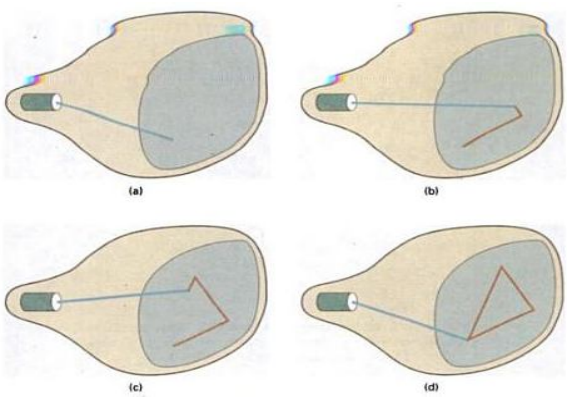
  Solution

  To refresh a display of 1024 * 768 pixels at a moderate refresh rate of 60 Hz requires

  Now, the time required to display a pixel on monitor is = 1/(1024 * 768 * 60) seconds = 21 ns.

2.4 Random Graphics or Vector Graphics

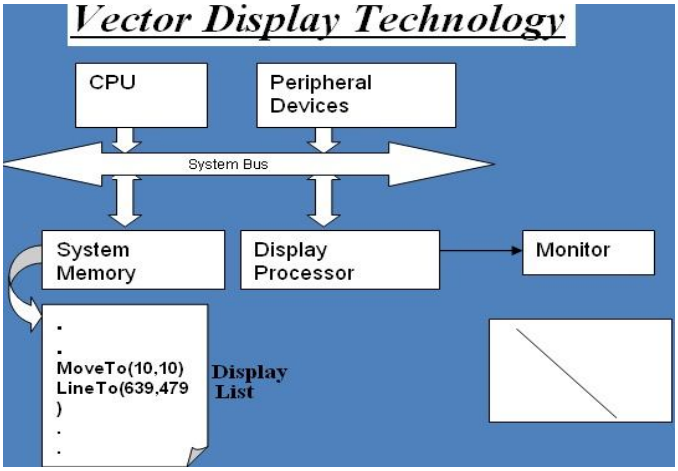
* Vector graphics (also called ***geometric modeling*** or ***object oriented graphics***) is the use of geometrical primitives such as points, lines, curves, and polygons, which are all based upon mathematical equations to represent images in computer graphics. It has complexity on drawing the complex images.
* The vector graphic system is seems on oscillators, medical diagnosis monitors etc.
* All modern current computer video displays *translate vector representations* of an image to a raster format. The raster image, containing a value for every pixel on the screen, is stored in memory.



2.4.1 Vector Display

* Developed in 60's also called ***random scan***, a ***stroke***, a ***line drawing*** or a ***calligraphic display***.
* This technique uses the geometrical shapes for constructing the image & hence if we require changing some portion of image in screen then it is not necessary to scan the whole screen as the raster system, we simply perform the change in that area only. Thus, it is more faster technique.
* In this technology we have to change the whole basic geometric shape in same manner so the special effects like shadowing are not possible.
* The image on the CRT's face must be constantly redrawn, refreshed, or updated.
* The two primary problems with vector displays are that they required constant updates to avoid fading, thus limiting the drawn scene's complexity, and they only drew wire frames.

2.4.2 Vector Display Technology



- The architecture of vector display technology consists of a central processing unit, display processor, a monitor, system memory and peripheral devices such as mouse and key board.
- A display processor is also called a *display processing unit* or *graphics controller*, which totally responsible for picture draw on the screen according to the command line stored on system memory.
- The application program and *graphics subroutine package* both reside in the system memory. A graphics subroutine package creates a *display list.* A portion of the system memory where display list resides is called a *refresh buffer.*
- A display list contains point and line plotting commands with end point coordinates as well as character plotting commands.

Advantages

- Can produce smooth output with high resolution & better time interval.
- No problem of stair case effect like raster scan display method because the random or vector display method use direct line drawing primitive or algorithms not the frame buffer.
- Better than raster for animation, requires only end point information.

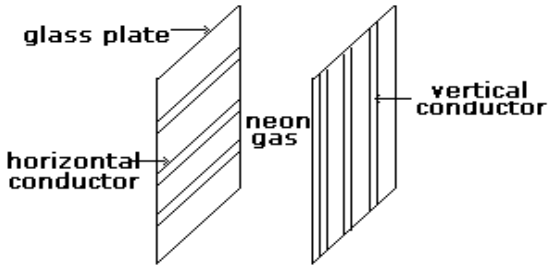
Limitations

- Can't fill area with patterns and manipulate bits
- Refreshing an image depends upon its complexity (more lines takes, longer time), flicker if complex image.

2.5 Flat Panel Display

* The term flat panel display refers to a class of video display devices that have reduced volume, weight, and power requirements compared to CRT.
* Thinner flat panel display can able to hang on a wall or able to wear on wrist.
* We can write on some flat panel displays
* Can be used in small TV monitor, calculators, pocket video games, laptop computers, armrest viewing of movies on airlines, as advertisement hoarding board etc.
* We can separate flat panel displays into two categories
    - Emissive Display
    - Non Emissive Display (LCD)

2.5.1 Emissive Display



- Device that convert electrical energy into light
- Plasma panels, thin film electroluminescent display and LED are examples of emissive display.
- ***Plasma panels***, also called ***gas-discharge display***, where region between two glass plates is filled with a mixture of gases such as neon, xenon.
- Picture definition is stored in a refresh buffer, and the firing voltages are applied to refresh pixel positions 60 times per second.
- One disadvantage of plasma panels has been that they were strictly monochromatic devices, but systems have been developed that are now capable of displaying color or gray scale.
- The intermediately filling gas is a light emitter as it converts the supplied voltage energy into the light energy.

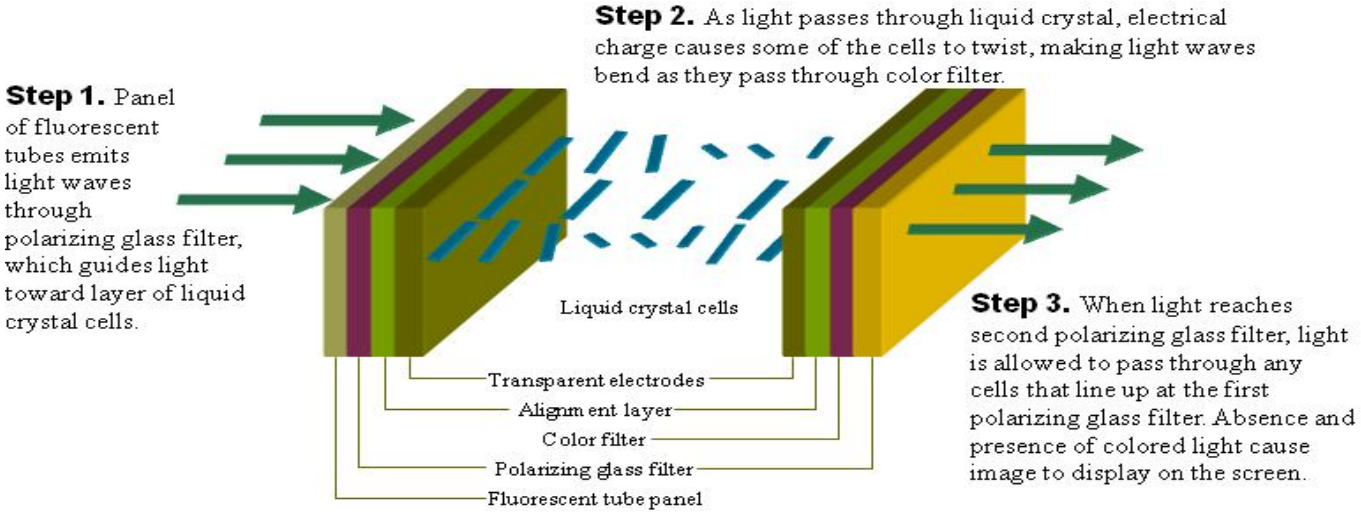
2.5.2 Non-Emissive Display

- Non emissive displays (or non-emitters but the orientation of supplied light is changed to provide the picture pattern on display monitor) use optical effects to convert sunlight or light from some other source into graphics patterns
- The most important example of non-emissive flat panel display is a Liquid Crystal Display (LCD).

2.6 Liquid Crystal Display (LCD)

* LCDs are organic molecules that, in the absence of external forces, tend to align themselves in crystalline structures.
* When an external force is applied they will rearrange themselves as if they were a liquid.
* Some liquid crystals respond to heat (i.e. *mood rings*), others respond to electromagnetic forces.
* In their unexcited or crystalline state the LCDs rotate the polarization of light by 90 degrees.
* In the presence of an electric field, LCDs behave like a liquid and align the small electrostatic charges of the molecules with the impinging E-field.
* Two glass plates, each containing a light polarizer at right angles to the other plate, sandwich the liquid crystal material
* Rows of horizontal transparent conductors are built into one glass plate, and columns of vertical conductors are put into the other plate
* The intersection of two conductors defines a pixel position.

* Picture definitions are stored in refresh buffer, and the screen is refreshed at the rate of 60 frames per second.
* Back lighting is also commonly applied using solid state electronic devices, so that the system is no completely dependent on out light sources.
* Colors can be displayed by using different materials or dyes and by placing a triad of color pixels at each screen location.



2.6.1 LCD operation

* A very small electric field is required to excite the crystals into their liquid state.
* Most of the energy used by an LCD display system is due to the back lighting.
* LCD's slowly transition back to their crystalline state when the E-field is removed.
* In scanned displays, with a large number of pixels, the percentage of the time that LCDs are excited is very small.
* Thus the crystals spend most of their time in intermediate states, being neither "On" or "Off". This behavior is indicative of *passive displays.*
* LCD displays have a native resolution.

LCD Off and LCD On state