
Computer Graphics

EG678EX

Hardware Concepts

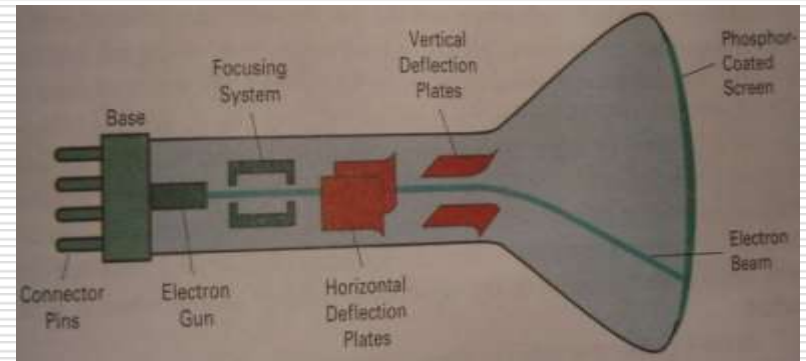
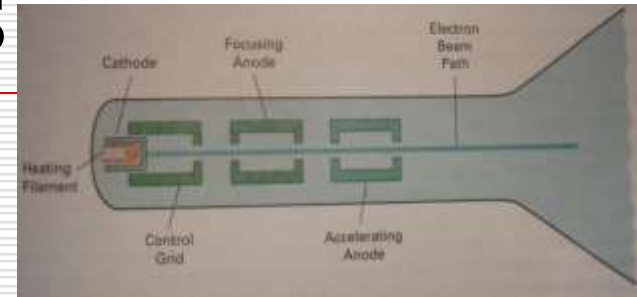
[Note: This presentation is a reference. For detailed study, students must read the text book]

Video Display Devices

❑ Cathode Ray Tube (CRT)

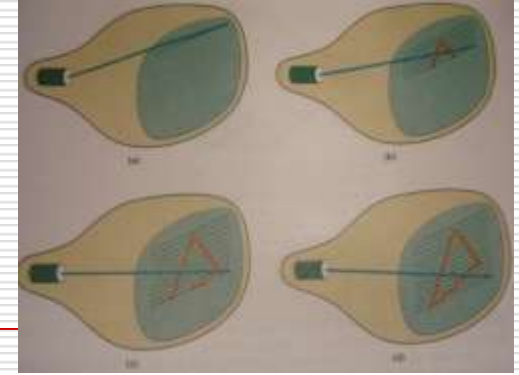
■ Components:

- ❑ Electron Gun → composed of heated metal cathode and control grid
- ❑ Accelerating Anode
- ❑ Focusing System
- ❑ Deflection system
- ❑ Phosphor Screen



CRT Operation

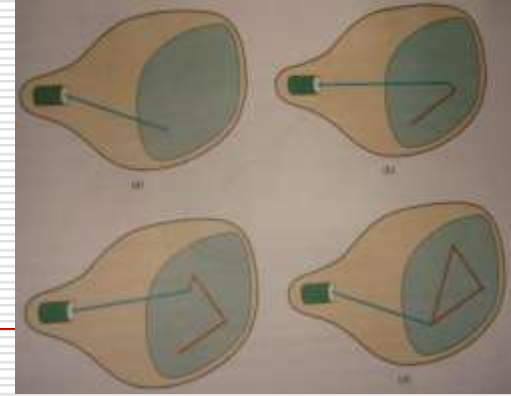
- ❑ Heat generated in cathode boils off the electrons
- ❑ Electrons are accelerated towards phosphor screen with high positive voltage applied at accelerating anode
- ❑ The negative voltage applied at cylindrical control grid controls the intensity of electron beam by repelling electrons
 - High negative voltage stops electron passing from the hole of control grid while small negative voltage decreases electron passage
- ❑ Focusing system concentrates electron beam to a small spot
 - In electrostatic focusing, electrons pass through positively charged metal cylinder
 - In magnetic focusing, coils are mounted outside of CRT Envelope which produces smallest spot
- ❑ Deflection System deflects electron beam horizontally and vertically
 - Magnetic → two pairs of coils
 - Electrostatic → two pairs of deflection plates
- ❑ **Refresh rate** depends on **persistence** of phosphor



Raster Scan Displays

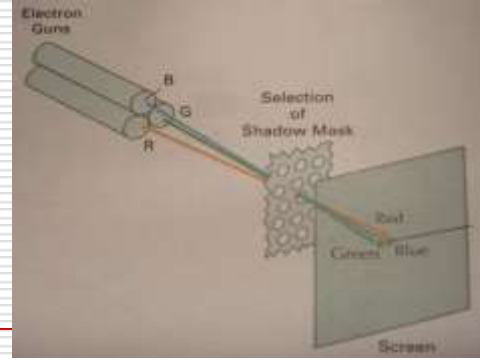
- ❑ The electron beam is swept across the screen, one row at a time from top to bottom
- ❑ The illuminated spot pattern is created by turning on or off when electron beam moves along each scan line
- ❑ Picture definition is stored in a memory area called **Refresh Buffer** (*Frame Buffer*)
 - Refresh Buffer holds the set of intensity values for all the screen points
 - Each screen points is known as **pixel** (short form of *picture element*)
- ❑ Example: Home television sets and printers
- ❑ For bilevel system (black and white) only 1 bit memory per pixel is sufficient
- ❑ For color system more bits per pixel are needed
 - For screen with resolution 1024 by 1024, and 24 bits per pixel (8 bits each for RGB) requires 3 MB of storage is needed
- ❑ Refreshing rate for raster scan display is usually 60 to 80 frames per second (i.e 1/80 or 1/60 seconds is taken for electron beam to scan from top left corner to bottom right corner)

Random Scan Display



- ❑ Electron beam is directed to the part of screen where picture is to be drawn
- ❑ Picture definition is stored as set of line-drawing commands in memory are known as refresh display file or simply refresh buffer
- ❑ Also known as Vector display

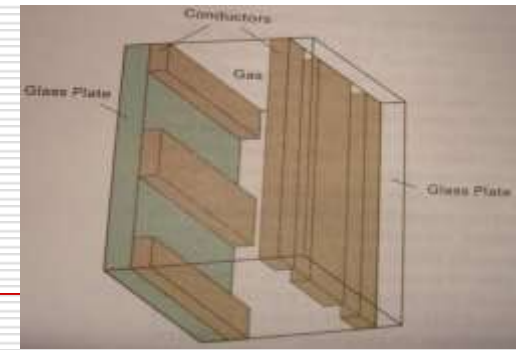
Color CRT Monitors



- ❑ Uses combination of phosphors that emit different colored light (usually Red, Green and Blue)
- ❑ Two basic methods for color picture display
 - Beam penetration method
 - ❑ Two layers of phosphor outer red layer and inner green layer
 - ❑ slow electron strikes outer to produce red and faster strikes inner layer to produce green color while intermediate produces orange and yellow
 - ❑ Only four colors are possible
 - Shadow mask method
 - ❑ Has three phosphor color dots (RGB) for each pixel position
 - ❑ Three electron guns one for each color dot
 - ❑ A shadow mask grid with holes aligned with the phosphor dot patterns
 - ❑ Electron beams passed from a hole of shadow mask activate the phosphor dot pattern to display color picture

Flat Panel Displays

- ❑ Emissive → converts electrical energy to light
 - Eg: plasma panels, thin-film electroluminescent display, LEDs
- ❑ Non Emissive → uses optical effects to convert sunlight or light from other source into graphics pattern
 - Eg: Liquid Crystal Display (LCD)

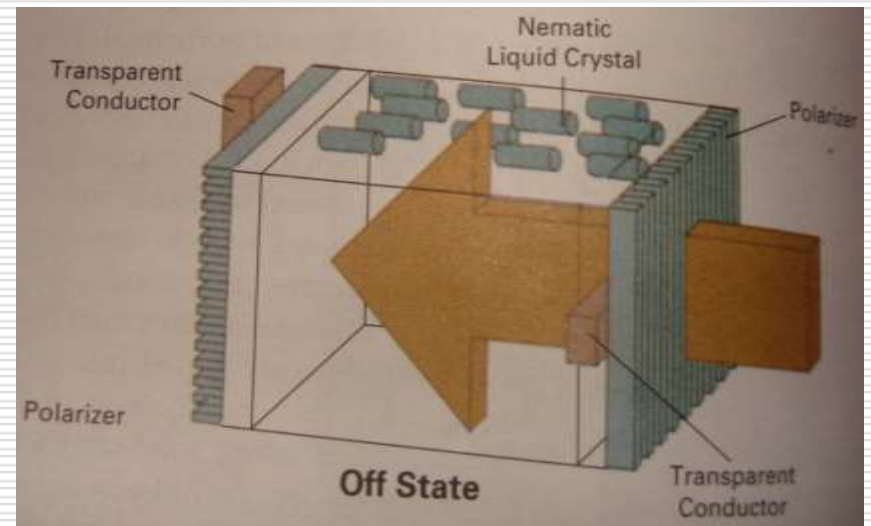
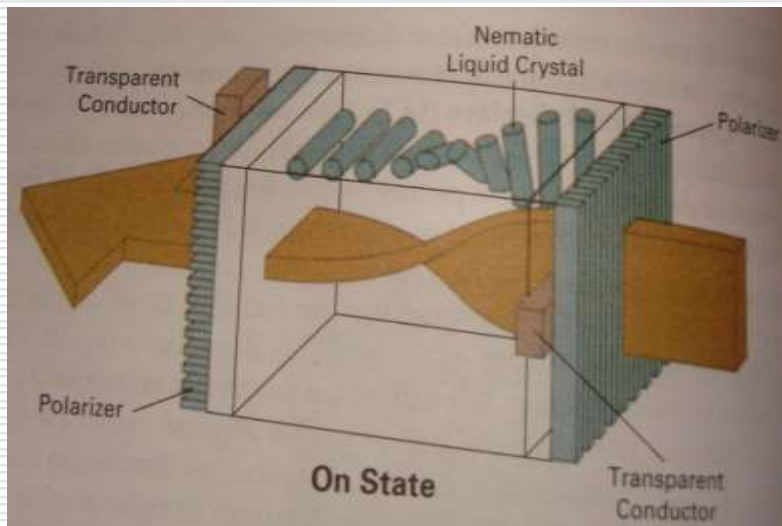


- ❑ Plasma Panel (gas discharge display)
 - The region between two glass plates are filled with a mixture of gases (*usually includes neon*)
 - Series of vertical conducting ribbon is placed on one plate and horizontal on the other
 - When firing voltage is applied between one horizontal and vertical conductor, the gas at intersection breaks up into glowing plasma ion and electrons
 - Refresh is needed
 - Monochromatic device; but now are capable of displaying color and grayscale
- ❑ Thin Film electroluminescent Display
 - Similar to plasma panel, but the space between glass plates is filled with phosphor, such as zinc sulfide doped with manganese
 - When electricity is passed through two electrodes, the phosphor become the conductor in that area and the electrical energy is absorbed by manganese atom to release the energy as a spot of light
 - Good color and grayscale are hard to achieve
- ❑ Light Emitting Diode (LED)
 - Diode matrix is arranged to form pixel position
 - Various voltage level produces various color lights

□ Liquid Crystal Display (LCD)

- Uses liquid having crystalline arrangement of molecules
- The liquid crystal compounds keep the long axes of the rod shaped molecules aligned
- Two glass plates each containing light polarizer at right angles to other plate are placed to sandwich the liquid crystal
- Horizontal conductors in one and vertical in other plate are placed thus intersection forms a pixel
- When no voltage is applied between conductors, the molecules are in **on state** so the polarized light is twisted by the molecule thus passes through the two plates and seen by the viewer
- When voltage is applied, the molecules are in **off state**, and light passing through one plate is stopped at other thus no light is seen by viewer
- **passive matrix**: voltage is applied to intersecting conductor to turn off the pixel
- **Active matrix**: uses transistor to control voltage at pixel locations
- Color display is possible by using different materials or dyes and by placing a triad of color pixels at each screen location

□ LCD

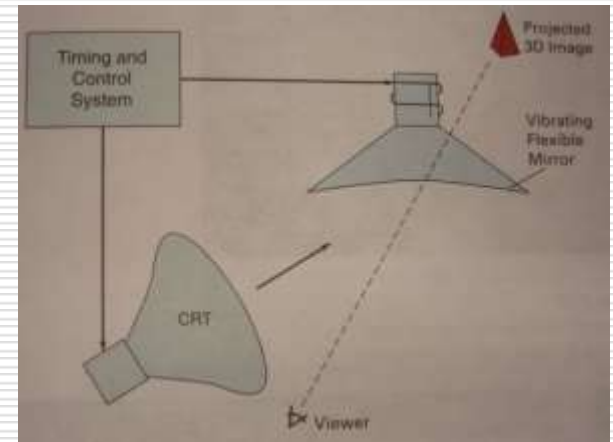


❑ 3D viewing Devices

- Displays 3-D scene
- Displayed by reflects CRT image from a vibrating mirror
- As mirror vibrates it changes focal length
- The vibration is synchronized with the display of an object on CRT so that each point in object is reflected from the mirror into a spatial position corresponding to distance of that point from a specified viewing position

❑ Stereoscopic and Virtual Reality Systems

- READ YOURSELF



Input Devices

- Keyboards
 - ASCII keys are used to input text string
 - Provides with features to facilitate entry of screen coordinates, menu selections or graphics functions
 - Function keys allow user to enter frequently used operations in a single stroke and cursor cont keys are used for cursor position or picture selection
 - Some keyboards consist of trackball or joystick
- Mouse
 - Pointing device to position cursor
 - Wheel or rollers are used to record the amount and direction of movement
 - Optical mouse uses optical sensors to detect mouse motion
 - One two or three buttons are included
 - [Note: For operation detail, please refer to internet sites such as wikipedia]
- Trackball and Spaceball
- Joysticks
- Data Globe
- Digitizers
- Image Scanners
- Touch Panels
- Light Pens

Hard Copy Devices

☐ Printers

■ Character Impact (Dot matrix) printers

- ☐ Similar to raster scan system
- ☐ Prints one character at a time and scans one line at a time while for next line paper is scrolled

■ Non impact

- ☐ Laser printers, ink jet, bubble jet
- ☐ In laser printers, laser beam creates a charge distribution on a rotating drum coated with a photoelectric materials such as selenium and toner is applied to the drum and then transferred to paper
- ☐ In ink jet printer, the ink is squirted in horizontal rows across a roll of paper. The electrically charged ink stream is deflected by an electric field to produce dot matrix patterns
- ☐ In bubble jet printers, ink is heated in a heating chamber to produce ink bubble. The heating chamber consists of heating filament