Computer Graphics
EG678EX

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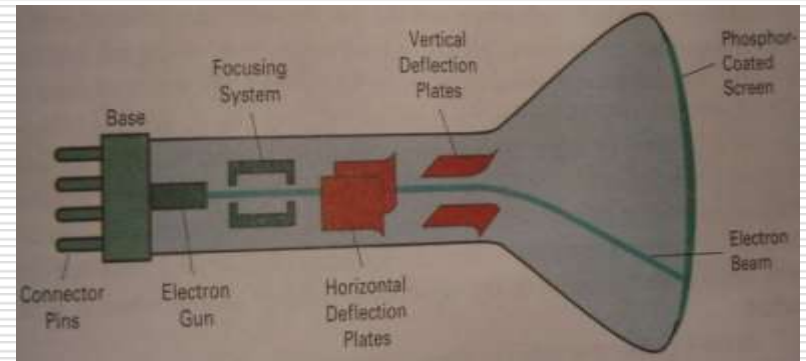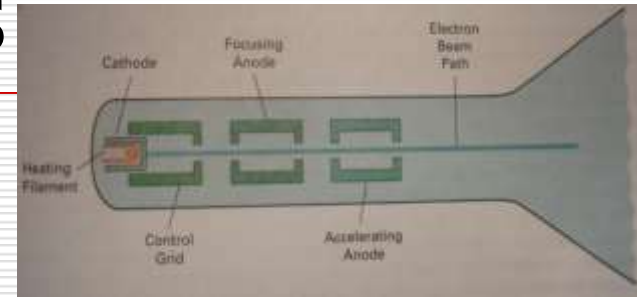
[Note: This presentation is a reference. For detailed study, students must read the text book]

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# 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 repealing 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
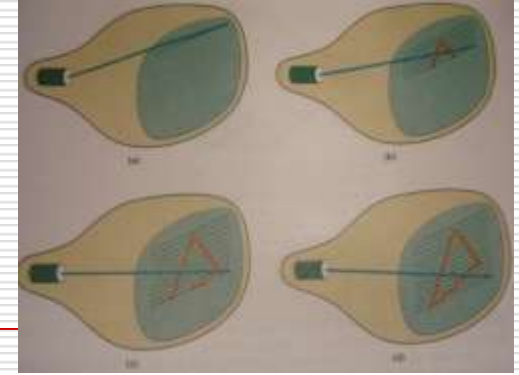
Raster Scan Displays

- ☐ 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
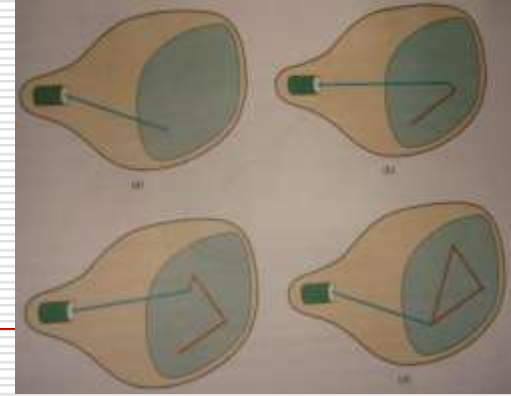
- ☐ Electron beam is directed to the part of screen where picture is to be drawn

- ☐ 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
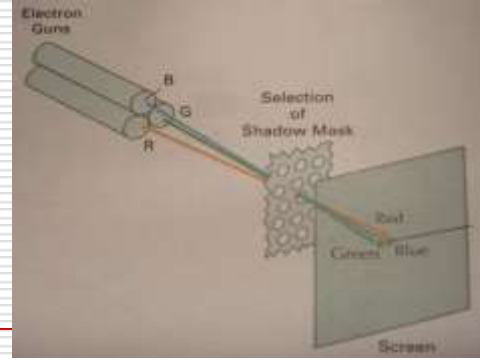
- ☐ Uses combination of phosphors that emit different colored light (usually Red, Green and Blue)
- ☐ Two basic methods for color picture display
  - ■ Beam penetration method
    - ☐ Two layers of phosphor outer red layer and inner green layer
    - ☐ slow electron strikes outer to produce red and faster 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)
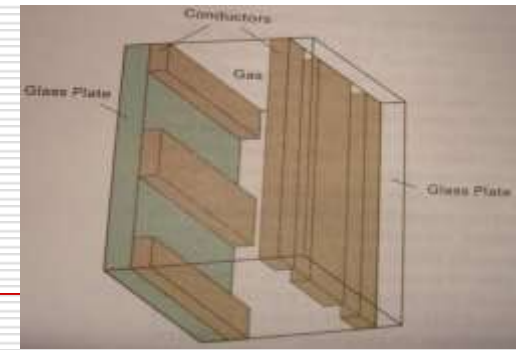
- Plasma Panel (gas discharge display)
  - The region between two glass plates are filled with a mixture of gases (*usually includes neon*)
  - Series of vertical conducting ribbon is placed on one plate and horizontal on the other
  - When firing voltage is applied between one horizontal and vertical 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
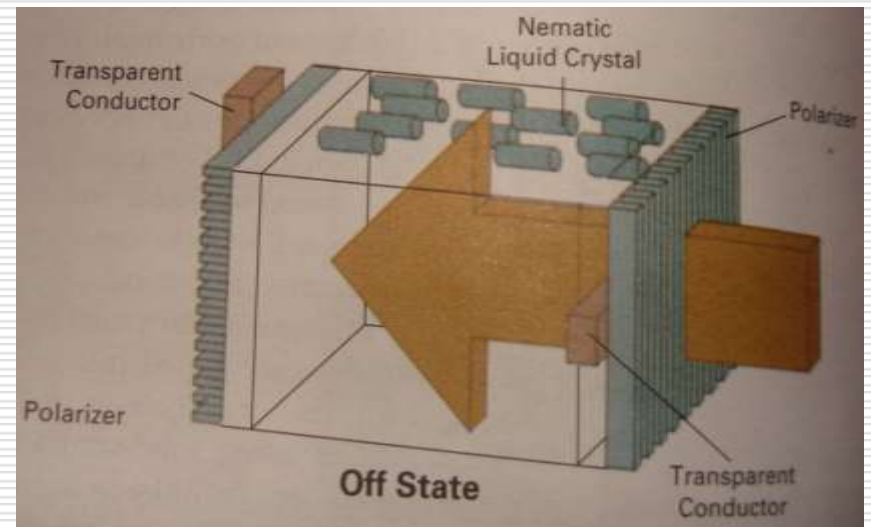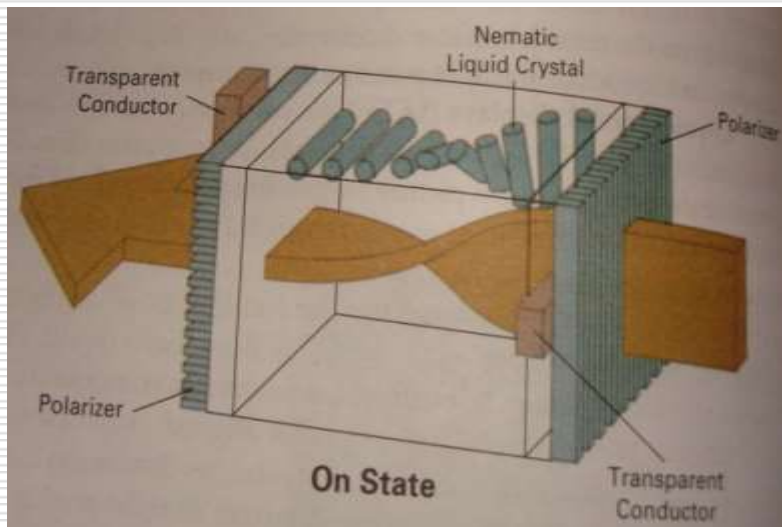
□ 3D viewing Devices
- Displays 3-D scene
- Displayed by reflects CRT image from a vibrating mirror
- As mirror vibrates it changes focal length
- The vibration is synchronized with the display of an object on CRT so that each point in object is reflected from the mirror into a spatial position corresponding to distance of that point from a specified viewing position

□ Stereoscopic and Virtual Reality Systems
- READ YOURSELF
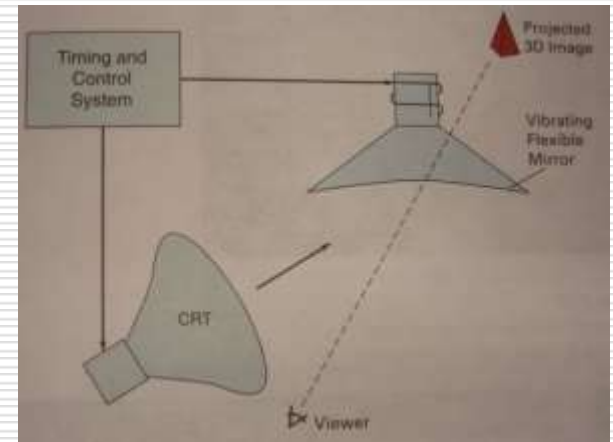
Input Devices

- ☐ 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 an tonner 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 ot matrix patterns
    - ☐ In bubble jet printers, ink is heated in a heating chamber to produce ink bubble. The heating chamber consists of heating filament