Introduction To Graphics Displays & Devices

Course Title: Computer Graphics

Course Code: CSE - 413

Outlines

- **Types of graphics display used in refresh CRT screen(raster and random scan display)*****
- **Color CRT monitors*****
- Direct View Storage Devices
- Flat-panel display devices
- Plasma Panel Display
- LCD (Liquid Crystal Display)**
- LCD VS CRT
- LED
- LED VS LCD
- **Mention some Graphics Card or Display Adapters with their characteristics.*****
- **What of mean by Input Devices? List them.**
- **What do you mean by Output Devices? List them.**

Raster scan display

- A raster scan display is based on intensity control of pixels in the form of a rectangular box called raster on the screen.
- In raster scan system electron beam sweeps across the screen from top to bottom cover one raw at a time and then back to top
- When the beam is moved from L→R it is ON and
- When the bean is moved from R →L it is OFF
- In black & white picture only 1bit required to store ‘0’(black) or ‘1’ (white), in this case buffer referred as bitmap. In color picture multiple bits are required for pixel position, in this case buffer referred as pixmap

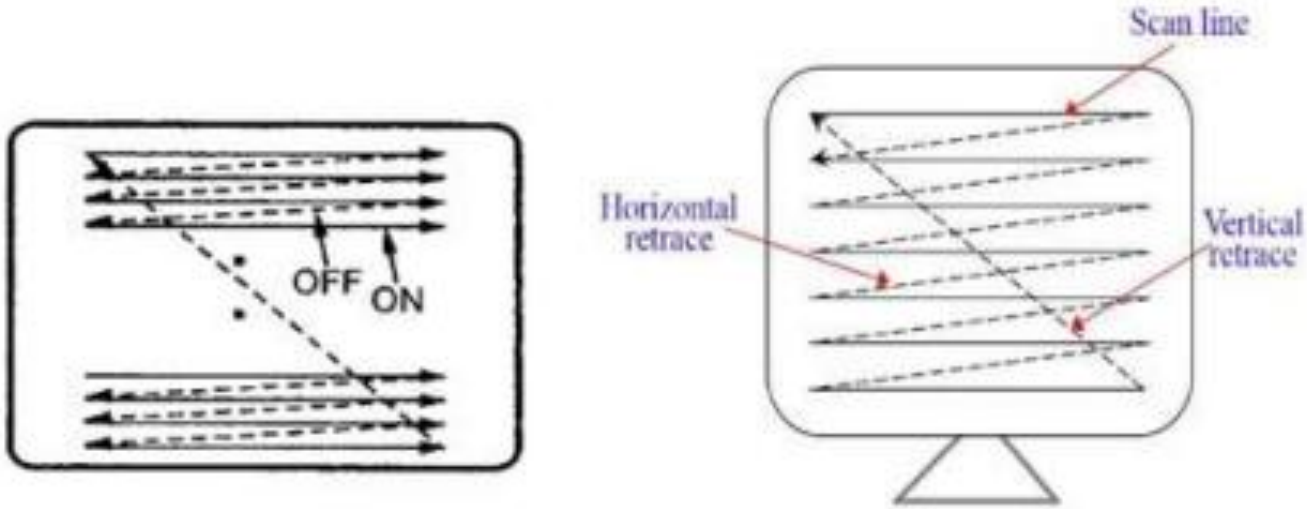


fig. Raster Scan CRT

Raster Scan Display

- Beam refreshing is two types. Horizontal retracing & vertical retracing
- After scanning each line from left to right, it reaches at the left end of the next line to scan the next line; which is called horizontal retrace.
- Similarly, after completing all lines in horizontal fashion it again reaches the top left corner to start rescanning the image and this is called vertical retrace. Normally, each vertical retrace takes 1/60th sec to avoid flickering
- The raster scan system can store information of each pixel position, so it is suitable for realistic display of objects.
- Raster scan provides a refresh rate of 60-80frames per second.
- Used in CRT monitor based on tv technology.

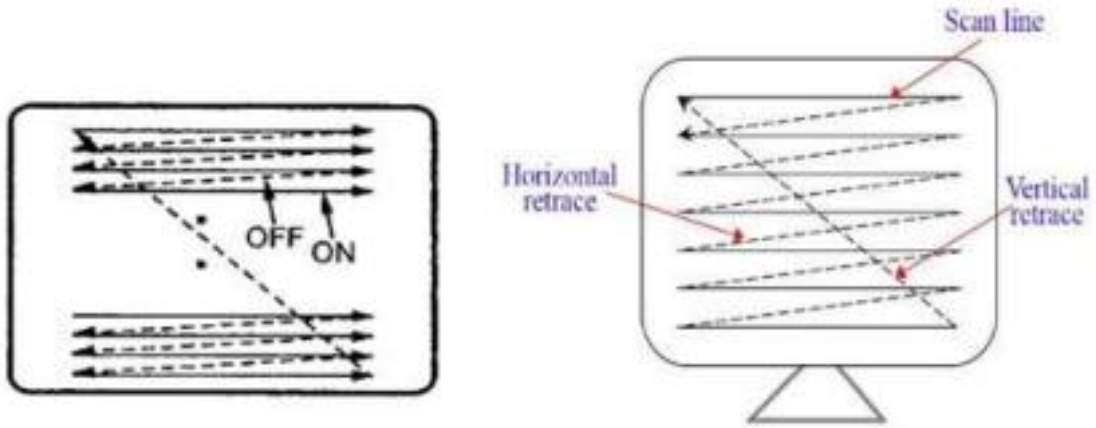


fig. Raster Scan CRT

Raster-scan System

- The raster scan system is a combination of some processing units. It consists of the control processing unit (CPU) and a particular processor called a display controller. Display Controller controls the operation of the display device. It is also called a video controller.

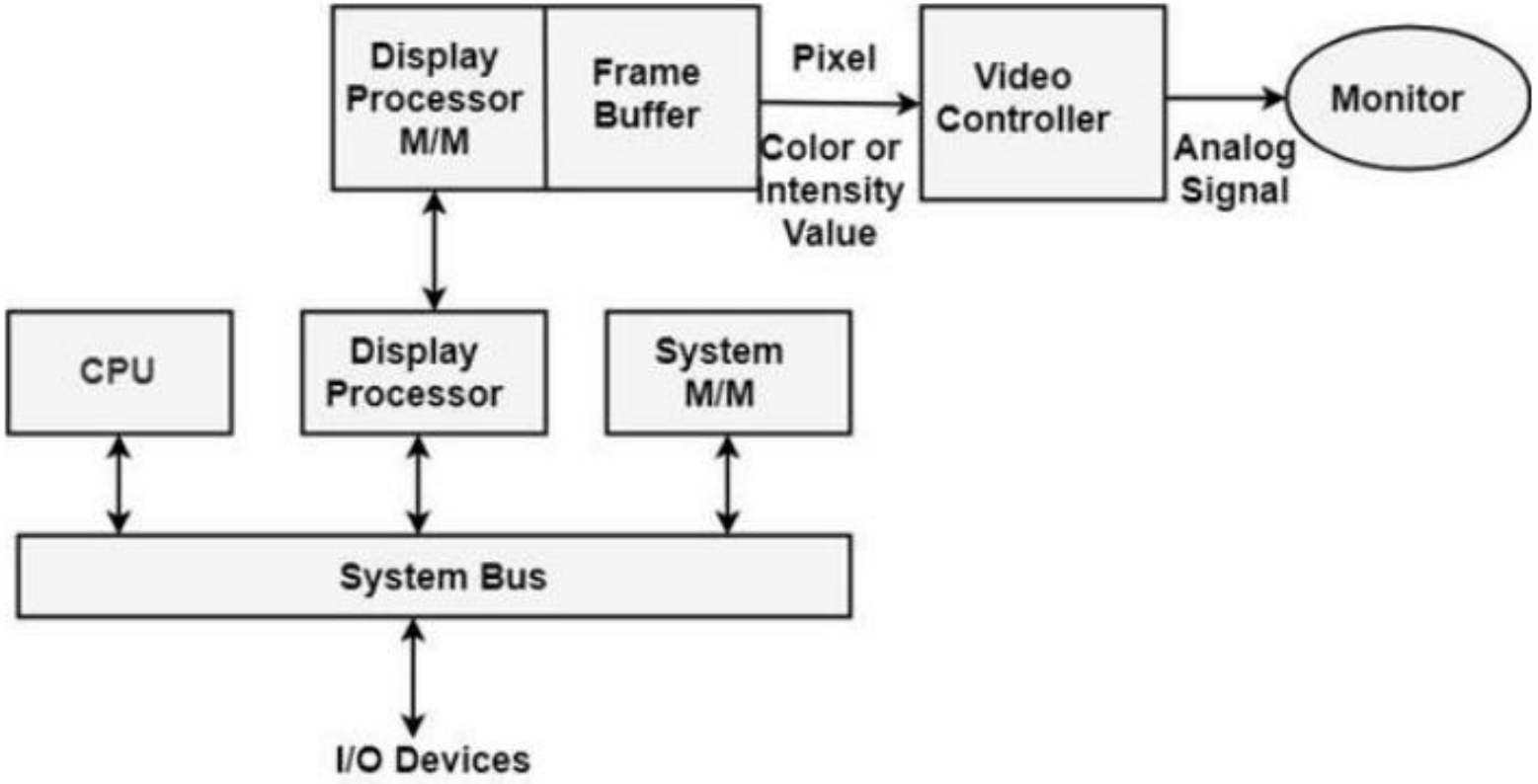
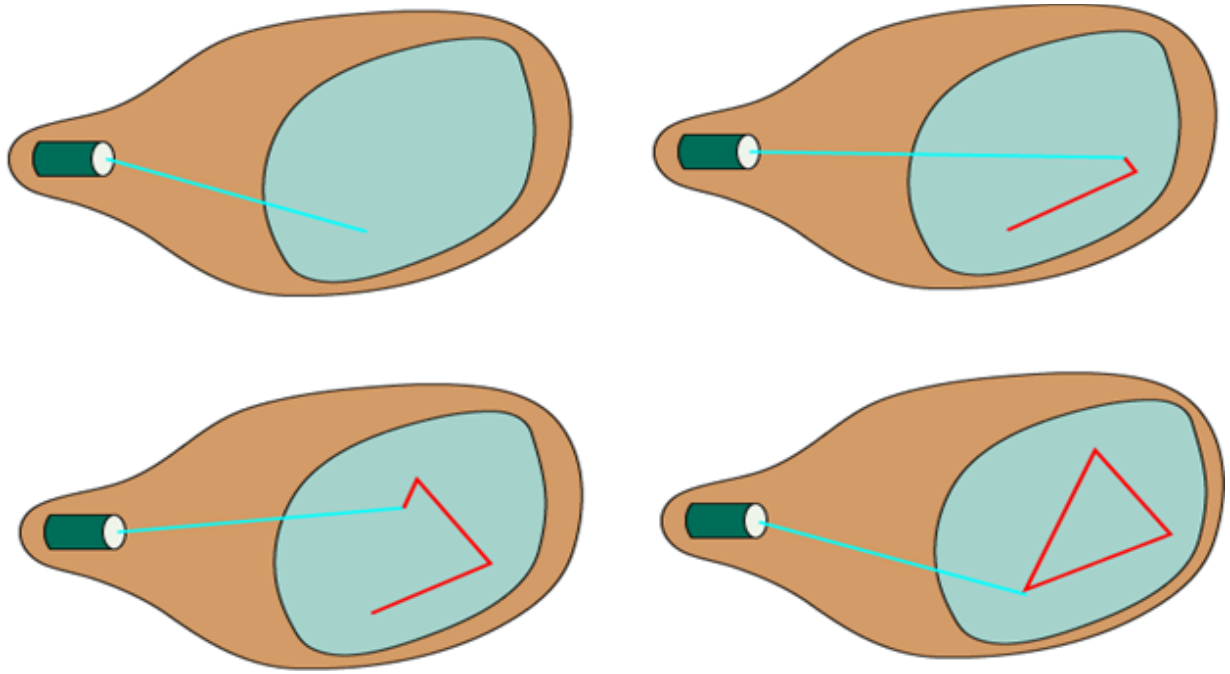


Fig: Architecture of a Raster Display System with a Display Processor

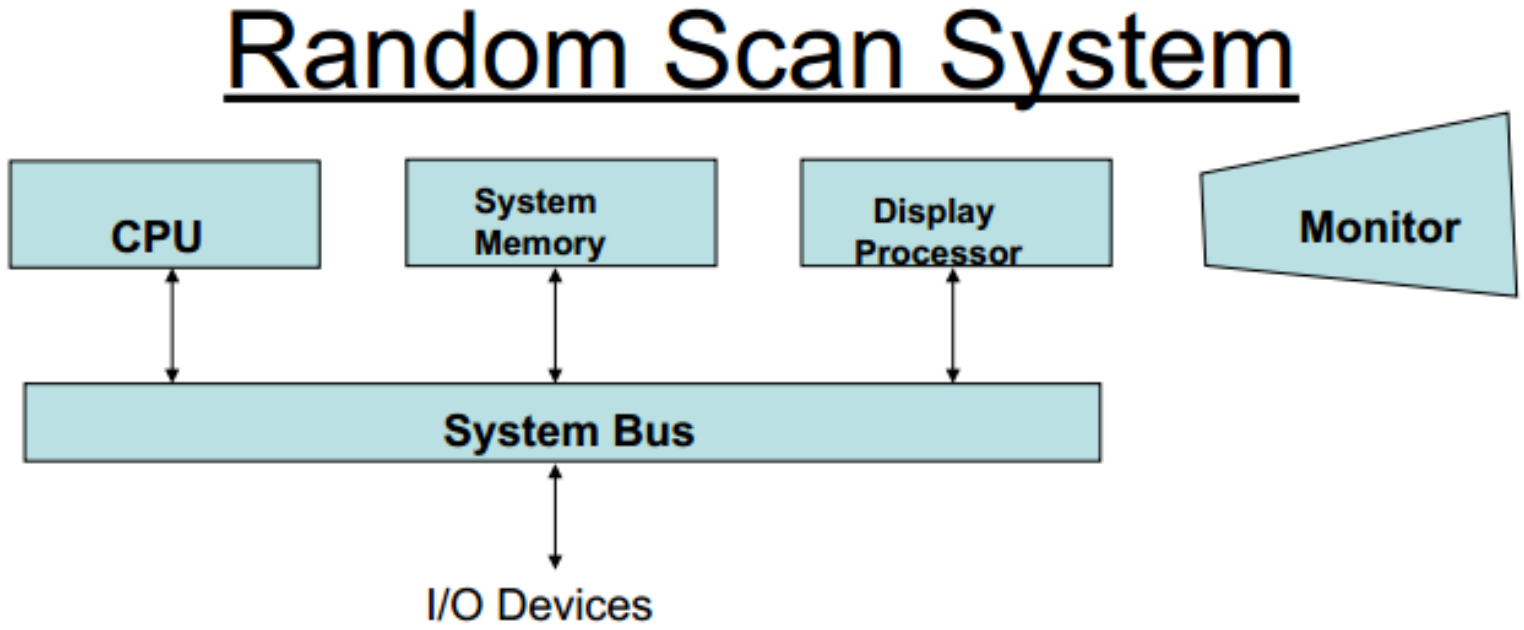
Random(vector) Scan Display

- In this technique, the electron beam is directed only to the part of the screen where the picture is to be drawn. This displays directly traces out only the desired lines on CRT
- To move the beam across the CRT, the information about both magnitude and direction is required. This information is generated with the help of vector graphics generator.
- In this system image consist of a set of line drawing commands referred to as refresh display file.
- Random scan display are designed to draw all the component lines of a picture 30 to 60 times per seconds.



Random-Scan Systems

- The organization of a simple random scan system is shown in following figure. An application program is input and stored in the system memory along with a graphics package.
- Graphics commands in the application program are translated by the graphics package into a display file stored in the system memory.
- This display file is then accessed by the display processor to refresh the screen. The display processor cycles through each command in the display file program once during every refresh cycle. Sometimes the display processor in a random scan system is referred to as a display processing unit or graphics controller.



Random(vector) Scan Display VS Raster Scan Display

Attributes	Random(vector) scan display	Raster scan display
e-beam movement	The beam is moved between the end point of the graphics primitives	The beam is moved all over the screen one scan line at a time, from top to bottom and then back to top.
Draw line & solid patterns	Lines & characters only solid pattern tough to fill	Display areas filled with solid colors or patterns.
Cost	High	Less
Modification of video images	Easy	Not easy
Refresh rate	30 to 60 times/sec	60-80 times/sec
Resolution	High	Low
Scan area	Only screen with view on an area is displayed	Whole screen is scanned
Scan conversion	No required	Required
Suitable for	Polygon drawing	Realistic view
Examples	Pen, plotter	Tv sets

Color CRT Monitors

- A CRT monitor displays color pictures by using a combination of phosphors that emit different colored light. With the combination of phosphor a range of colors can be displayed. There are two techniques used in color CRT monitors:
- **1. Beam Penetration Method**
- **2. Shadow Mask Method**

Beam Penetration Method

Beam penetration method is used with random scan display where CRT is coated with 2-layers of phosphor, usually red and green.

→ Outer layer is red phosphor

→ Inner layer is green phosphor

The Display color depend on how far e-beam penetrate the phosphor layers:-

1. Low e-beam speed strikes only red phosphor and produced red traces on screen.

2. High e-beam speed strikes the green phosphor and produces green traces on screen

3. Medium e-beam speed strikes the both phosphor and produces colors of combination of red & green like yellow and orange color.

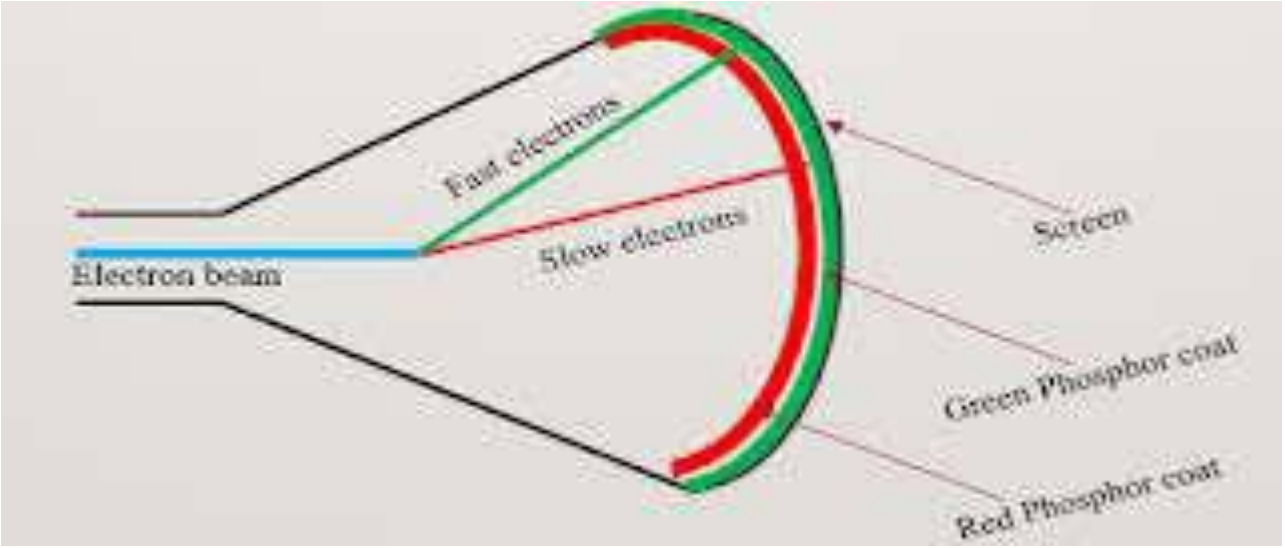
Advantages:

-cheap

Dis-advantages:

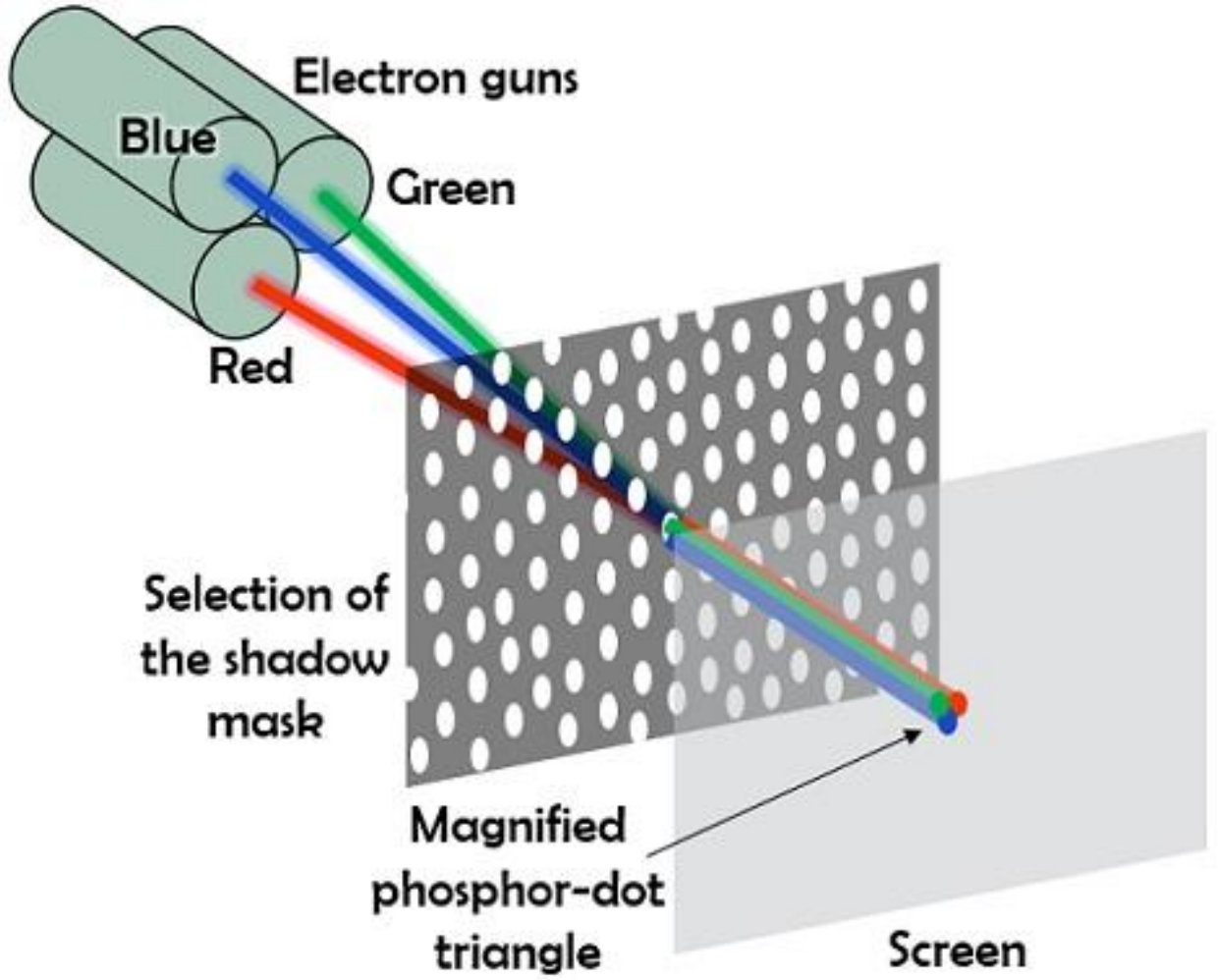
-only 4-color produce

-Bad quality



Shadow Mask Method

- Used in raster scan display and produces wide range of color
- 3 phosphor dots of R.B.G at each pixel position and emits corresponding color.
- 3 e-gun or e-beam for each color and a shadow mask grid just behind the phosphor coated screen.
- Shadow mask grid consist of holes and align with dot patterns
- 3 e-beam are defected and focused as a group on shadow mask and excite a dot triangle(Δ) by passing hole. One beam activate only one corresponding colors. Color generated by combination of 3-colors.



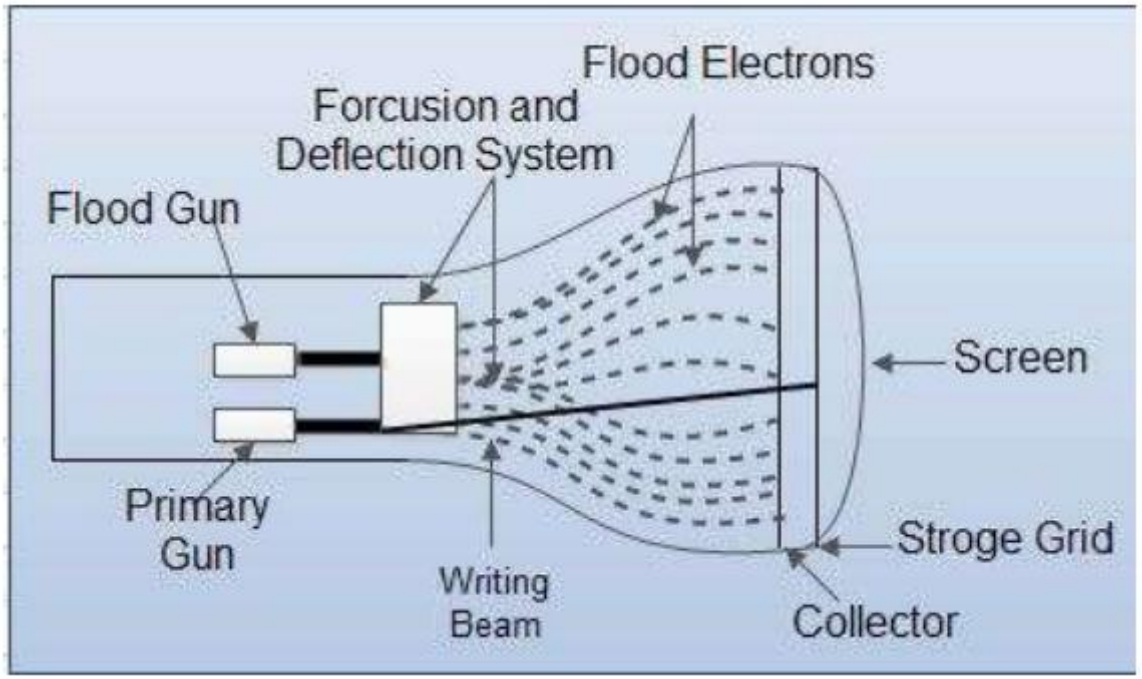
Shadow Masking in Colour CRT

Beam Penetration Method Vs Shadow Mask Method

Attributes	Beam penetration method	Shadow mask method
Where used	Random scan display	Raster scan display
Color available	Red, green	Red, green, blue
Color generate	Only 4 color. Red, green, orange, yellow	Millions of colors can display
Color dependency	Only 4 colors are available because the colors depend on the speed of e-beam	Millions of color are available because the colors depends on the type of ray
Cost	low	High
Picture quality	Poor	Very realistic
Resolution	High	Low
E-gun	One e-gun is used	Three e-gun is used
Realistic view	Not suitable for realistic view	suitable

Direct View Storage Devices

- Conceptually the Direct View Storage Tube (DVST) behaves like a CRT with highly persistent phosphor. Pictures drawn on there will be seen for several minutes (40-50 minutes) before fading. The term "storage tube" refers to the ability of the screen to retain the image which has been projected against it, thus avoiding the need to rewrite the image constantly.
- 1. Primary guns: It is used to store the picture pattern.
- 2. Flood gun or Secondary gun: It is used to maintain picture display

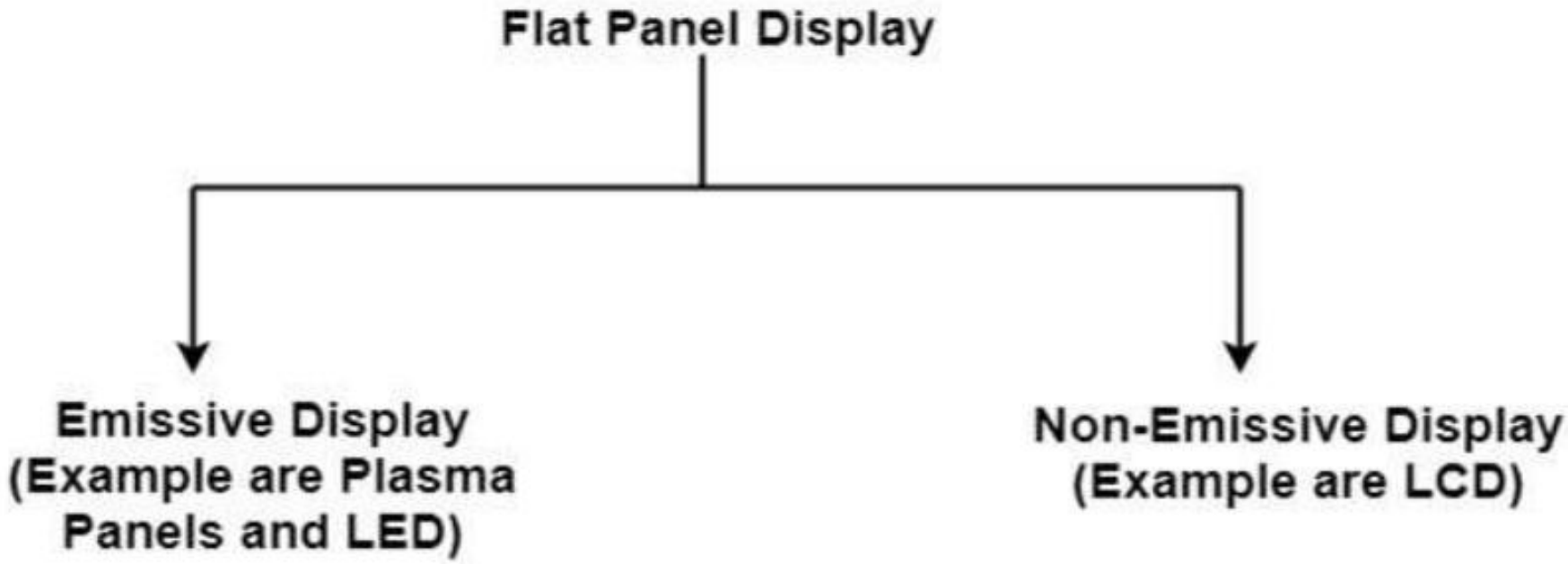


Advantage:
1. No refreshing is needed.
2. High Resolution
3. Cost is very less

Disadvantage:
1. It is not possible to erase the selected part of a picture.
2. It is not suitable for dynamic graphics applications.
3. If a part of picture is to modify, then time is consumed.

Flat-Panel Displays

- This is emerging technology slowly replacing CRT monitors. The flat-panel displays have following properties: Little Volume, Light Weight, Lesser Power consumption
- Example: Small T.V. monitor, calculator, pocket video games, laptop computers, an advertisement board in elevator.
- **1. Emissive Display:** The emissive displays are devices that convert electrical energy into light. Examples are Plasma Panel, thin film electroluminescent display and LED (Light Emitting Diodes).
- **2. Non-Emissive Display:** The Non-Emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. Examples are LCD (Liquid Crystal Device).



Plasma Panel Display

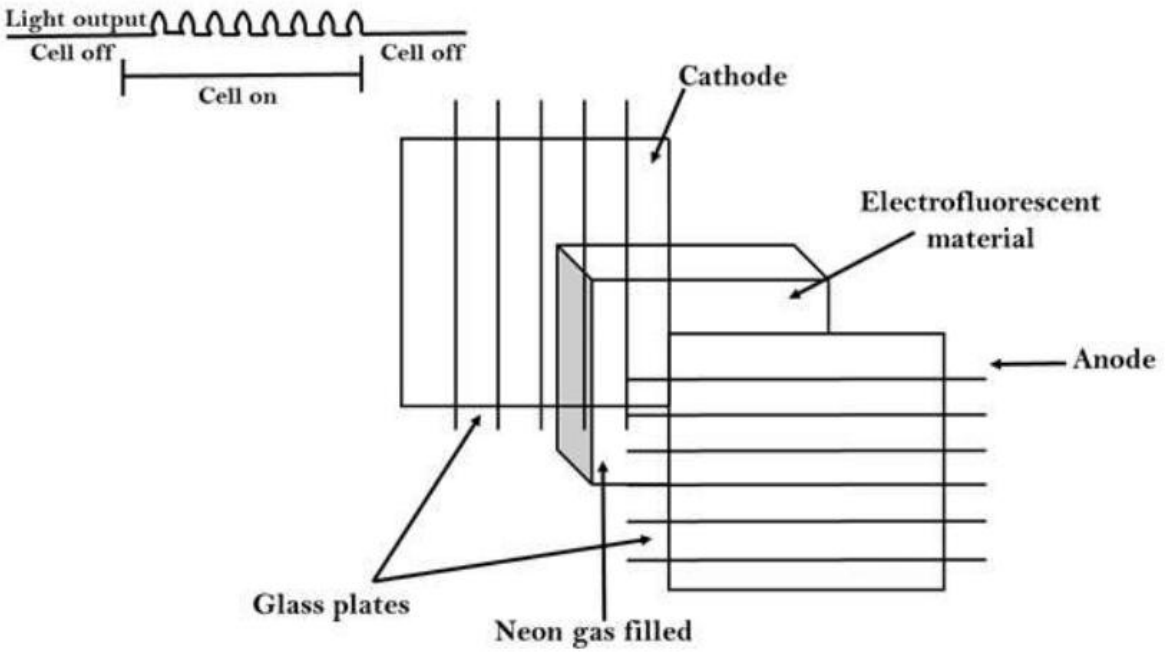
Plasma-Panels are also called as **Gas-Discharge Display**. It consists of an array of small lights. Lights are fluorescent in nature. The essential components of the plasma-panel display are:

1. Cathode: It consists of fine wires. It delivers negative voltage to gas cells. The voltage is released along with the negative axis.

2. Anode: It also consists of line wires. It delivers positive voltage. The voltage is supplied along positive axis.

3. Fluorescent cells: It consists of small pockets of gas liquids when the voltage is applied to this liquid (neon gas) it emits light.

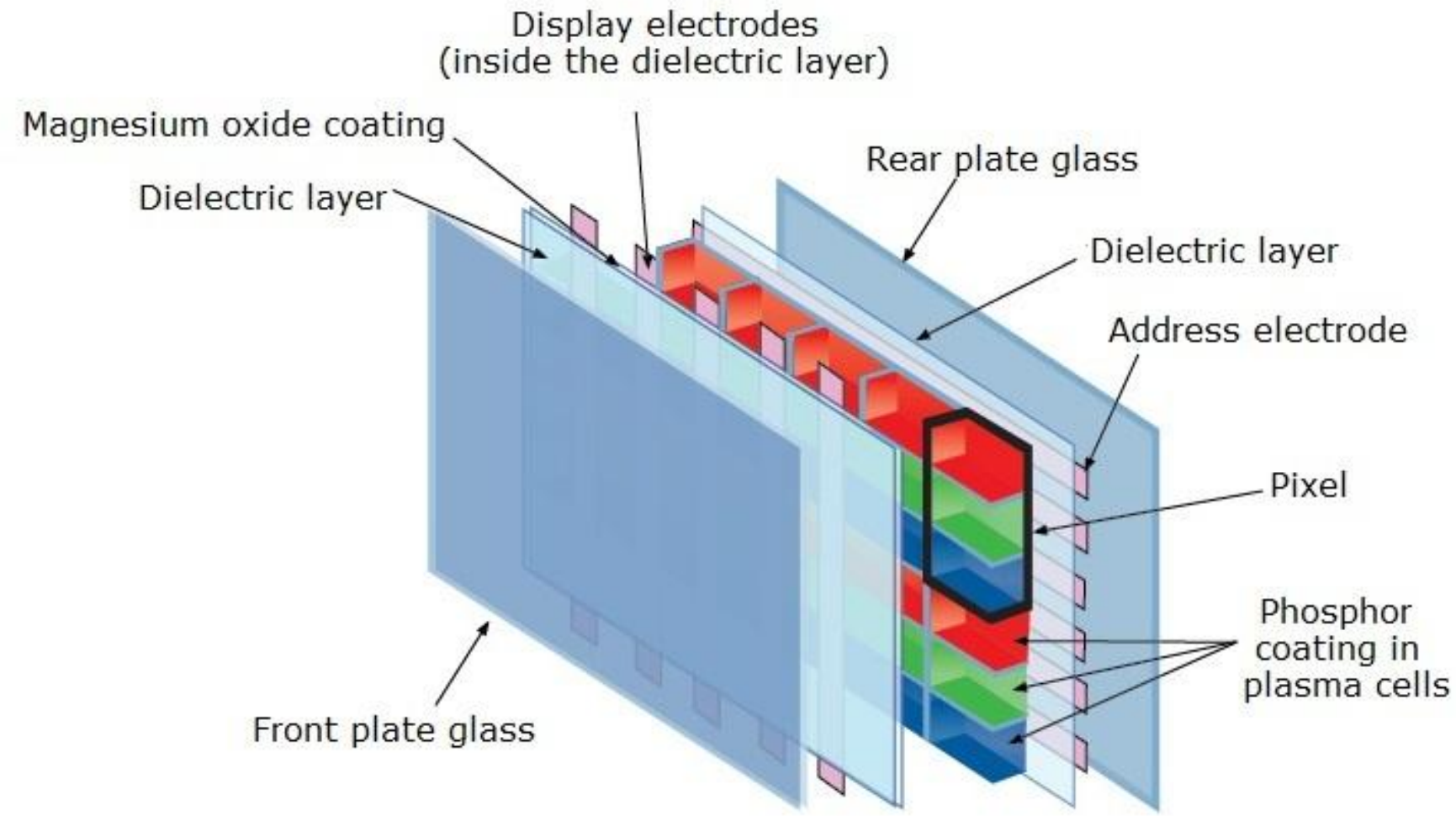
4. Glass Plates: These plates act as capacitors. The voltage will be applied, the cell will glow continuously.



Advantage:
1. High Resolution
2. Large screen size is also possible.
3. Less Volume
4. Less weight
5. Flicker Free Display

Disadvantage:
1. Poor Resolution
2. Wiring requirement anode and the cathode is complex.
3. Its addressing is also complex.

Plasma Panel Display

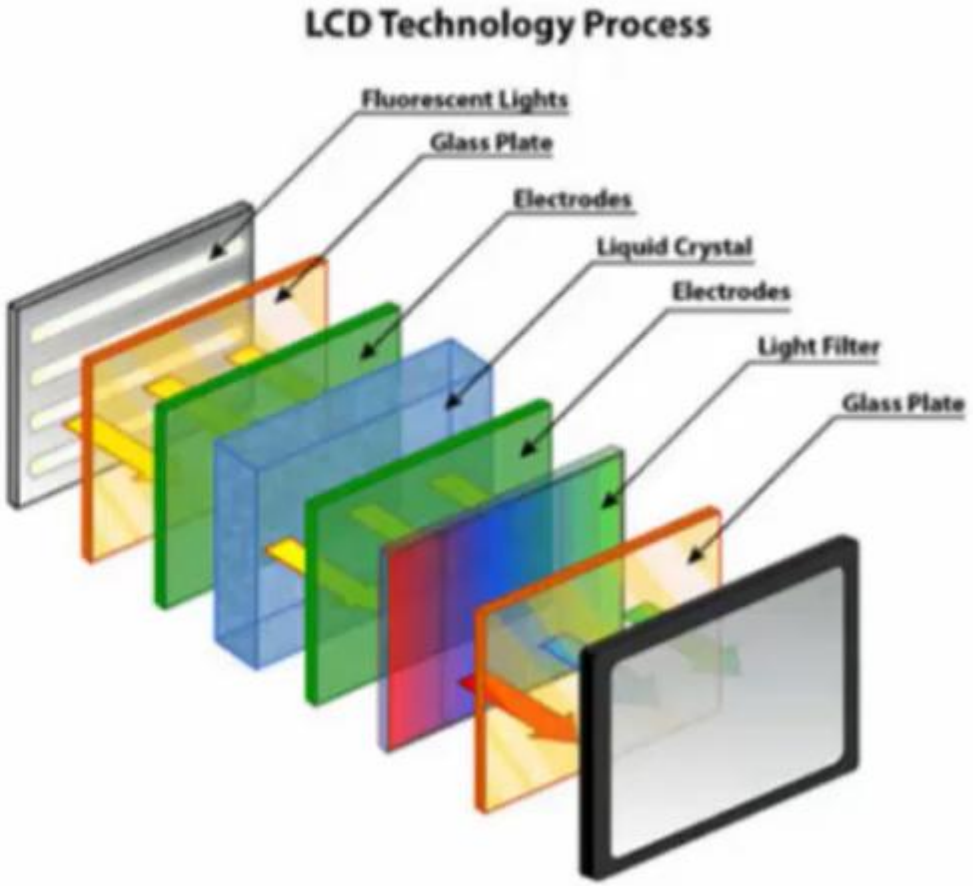


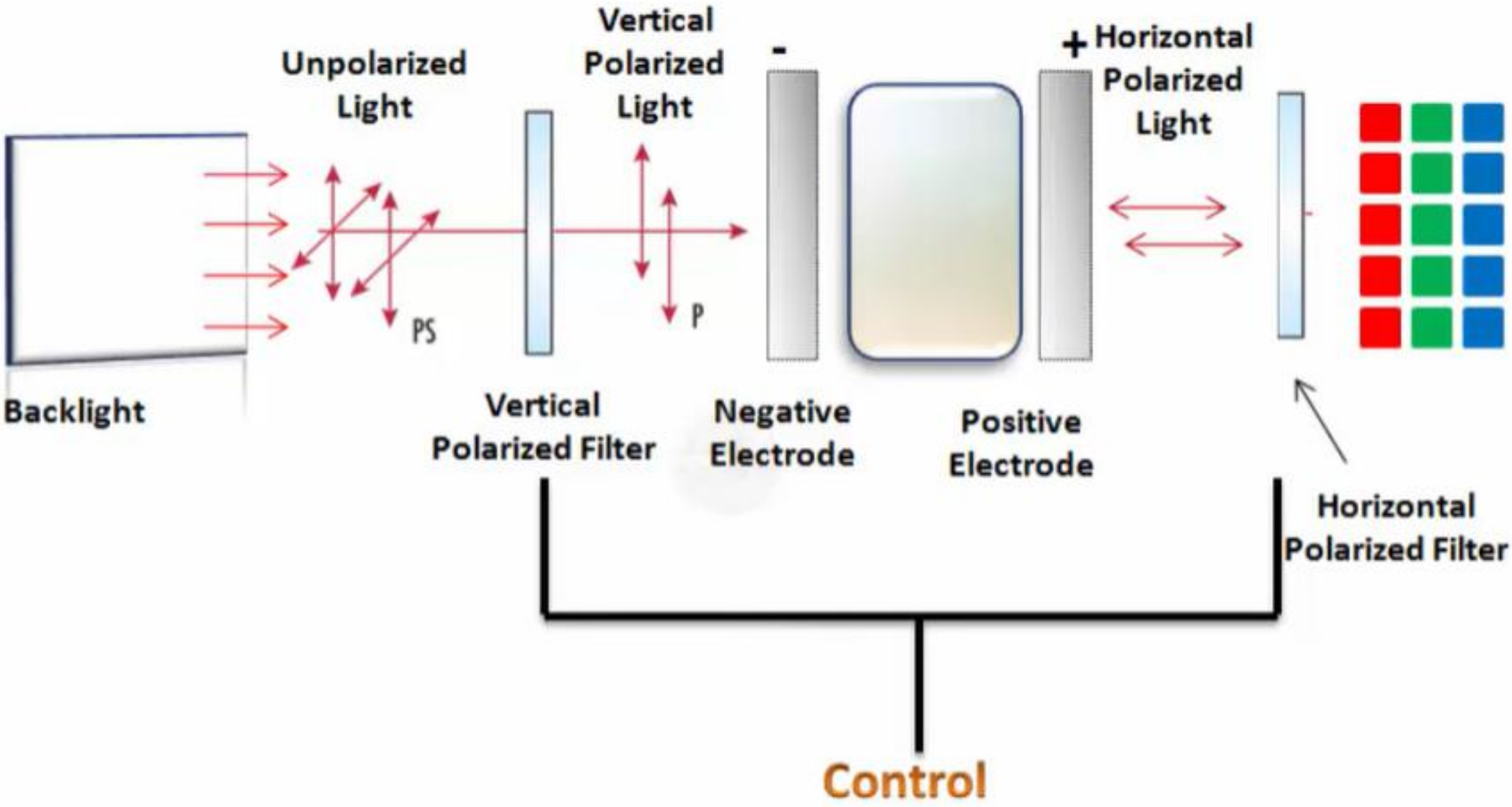
LCD (Liquid Crystal Display)

Construction of LCD DISPLAY

1. Backlight
2. Polarized Filter Horizontal and Vertical
3. Liquid Crystal
4. Pixel – Color Filter

- ✓Light
- ✓Color Filter
- ✓Control Light





Working of LCD

Working principle of LED

- When light from a blacklight source(CCFL) is emitted and allowed to fall on the vertical polarizer, then the unpolarized light by the blacklight source get vertically polarized.
- Initially no external voltage is applied between the two positive(+ve) & negative(-ve) electrons and the molecules of the liquid crystal remain twisted.
- This causes the vertically polarized light to get horizontally polarized due to orientation of the molecules in the liquid crystal.
- The horizontally polarized light from the nematic liquid crystal is fed to the horizontal polarizer and it passes the light through it causing illumination of the pixel.
- Hence, generate a visible image on the screen.
- When the voltage is applied to the electrodes(+,-), the liquid crystal molecules untwist, so vertically polarized light cannot pass throw it and the screen shows black.
- TFT(Thin Film Transistor) control the brightness of colors by transistors.

Advantages:
1. **Energy Efficient**: Uses less power, ideal for portable devices.
2. **Compact & Lightweight**: Perfect for slim gadgets like laptops.
3. **Low Heat Generation**: Minimal heat output extends device lifespan.
4. **Sharp Images**: High clarity and reduced glare for better visuals.
5. **Safe Radiation Levels**: Emits very little electromagnetic radiation.

Disadvantages:
1. **Limited Viewing Angles**: Image quality degrades from the side.
2. **Motion Blur**: Slower response times affect fast scenes.
3. **Color & Contrast Limitations**: Blacks are less deep, colors less vivid.
4. **Dead Pixels**: Risk of pixels getting stuck or not working.
5. **Backlight Bleeding**: Uneven backlighting may cause brightness issues.
6. **Temperature Sensitivity**: Extreme conditions impact performance.

Applications:
1. **Electronics**: TVs, monitors, smartphones, and tablets.
2. **Automotive**: Dashboards, GPS, and infotainment systems.
3. **Medical**: Displays in diagnostic machines and monitors.
4. **Industrial**: Equipment control panels and POS screens.
5. **Entertainment**: Arcade games and gaming monitors.
6. **Aerospace**: Cockpit displays and in-flight entertainment.
7. **Public Displays**: Digital signage and kiosks.
8. **Wearables**: Smartwatches and fitness trackers

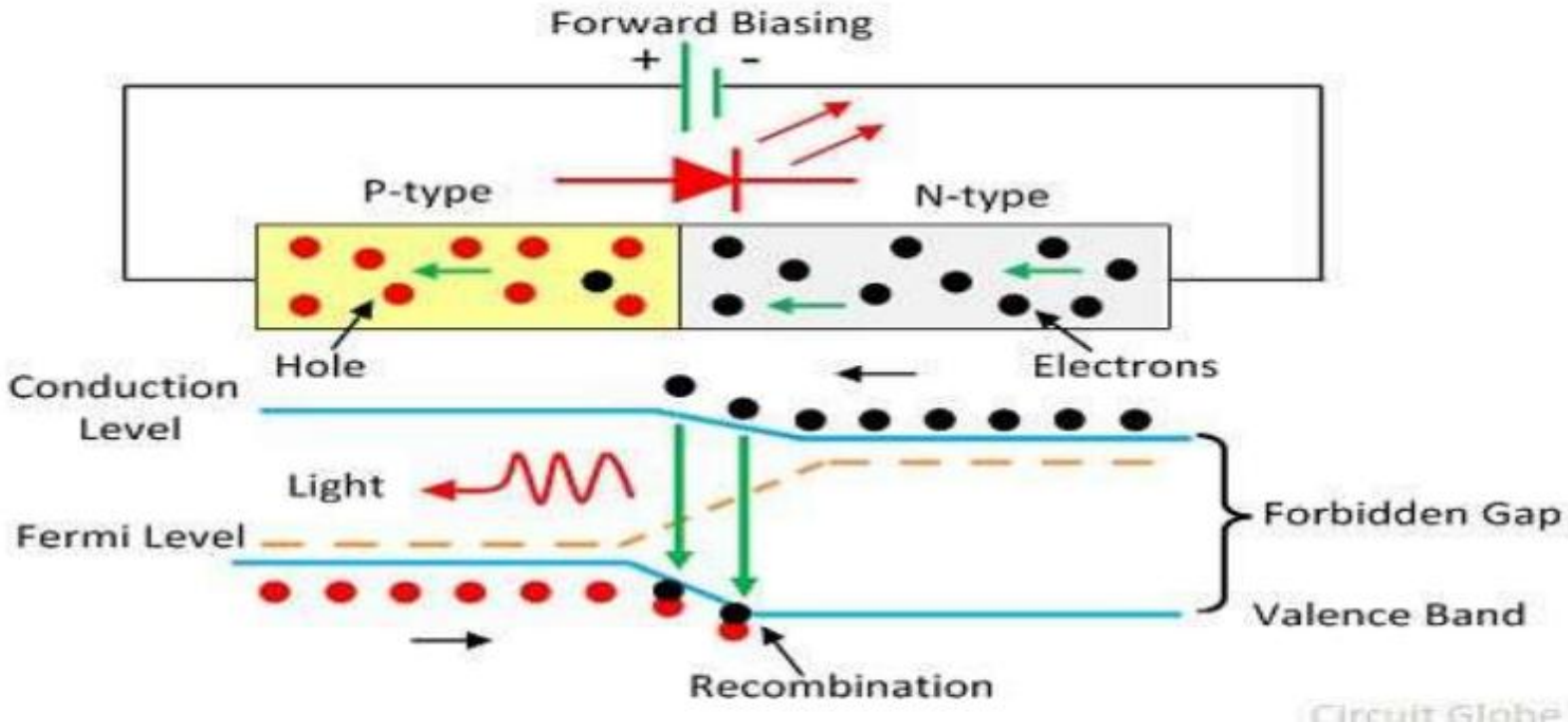
Feature	CRT Monitor	LCD Monitor
Technology	Uses electron beams and a vacuum tube to display images.	Uses liquid crystals and a backlight to produce images.
Size & Weight	Bulky and heavy, with large depth.	Slim, lightweight, and space-saving.
Power Consumption	Consumes more power.	More energy-efficient.
Image Quality	Can produce deep blacks and good color accuracy.	Sharp images, but may have contrast limitations.
Viewing Angle	Good viewing angles, but image may distort at the edges.	Limited viewing angles, though modern panels have improved this.
Refresh Rate	High refresh rates, suitable for fast-moving images.	Generally lower refresh rates, but high-refresh LCDs are available.
Radiation	Emits more electromagnetic radiation.	Minimal radiation emission, safer for long-term use.
Lifespan	Shorter lifespan due to heat generation and wear.	Longer lifespan with less heat production.
Motion Blur	Little to no motion blur, good for action scenes and gaming.	Potential for motion blur in older models, but newer ones have improved.
Cost	Generally cheaper but becoming obsolete.	More expensive, but prices have been dropping.

Light Emitting Diode (LED)

The LED is a PN-junction diode which emits light when an electric current passes through it in the forward direction. In the LED, the recombination of charge carrier takes place. The electron from the N-side and the hole from the P-side are combined and gives the energy in the form of heat and light. The LED is made of semiconductor material which is colorless, and the light is radiated through the junction of the diode. The LEDs are extensively used in segmental and dot matrix displays of numeric and alphanumeric character. The several LEDs are used for making the single line segment while for making the decimal point single LED is used

- When the energy of electrons decreases from the higher level to lower level, it emits energy in the form of photos.
- The energy of the photos is equal to the gap between the higher and lower level.
- Energy of photon = higher level - lower level

The LED is connected in the forward biased, which allows the current to flows in the forward direction. The flow of current is because of the movement of electrons in the opposite direction. The recombination shows that the electrons move from the conduction band to valence band and they emits electromagnetic energy in the form of photons. The energy of photons is equal to the gap between the valence and the conduction band.



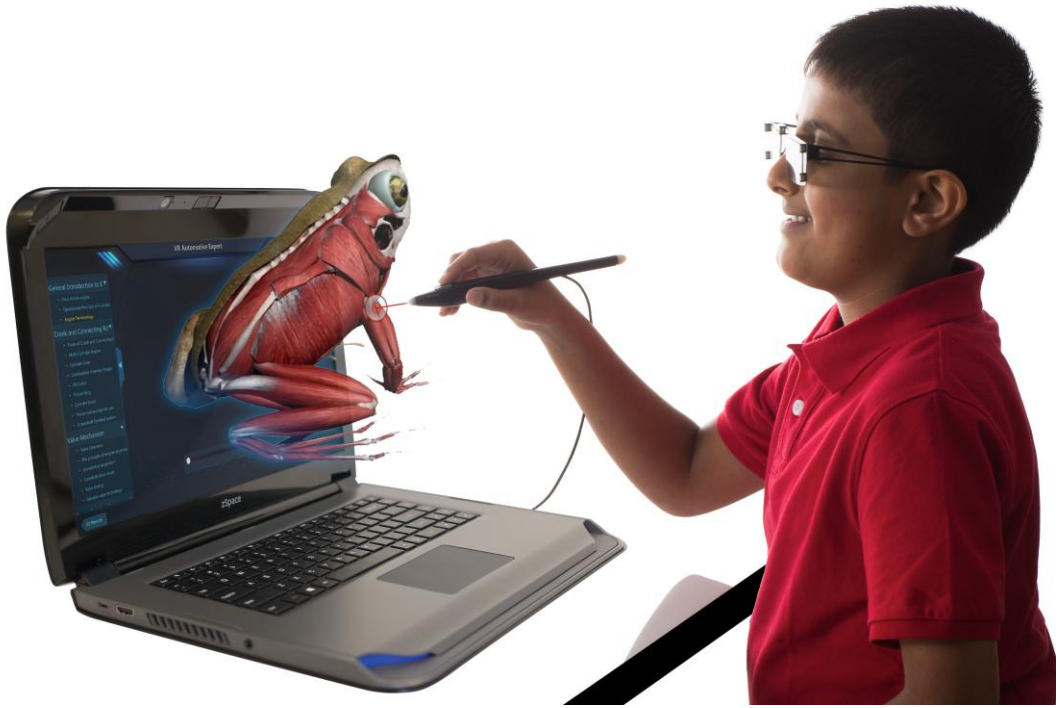
Difference between LCD & LED monitor		
Feature	**LCD Monitor**	**LED Monitor**
Backlight Technology	Uses CCFL (Cold Cathode Fluorescent Lamp) for backlighting.	Uses LED (Light Emitting Diodes) for backlighting.
Power Consumption	Consumes more power due to CCFLs.	More energy-efficient with lower power consumption.
Brightness	Less bright, suitable for indoor use.	Brighter, better for outdoor and well-lit environments.
Color Accuracy	Good color accuracy but limited contrast.	Better color accuracy and contrast, especially with full-array or RGB LEDs.
Contrast Ratio	Lower contrast ratios, making blacks appear more gray.	Higher contrast ratios with deeper blacks.
Thickness	Thicker and bulkier due to CCFL tubes.	Slimmer and more compact design.
Lifespan	Shorter lifespan compared to LED monitors.	Longer lifespan due to efficient LED technology.
Environmental Impact	Uses mercury in CCFLs, which is harmful to the environment.	More eco-friendly, as LEDs do not contain mercury.
Cost	Generally cheaper than LED monitors.	Typically more expensive but offers better performance.
Image Quality	Good, but less vibrant colors and contrast.	Superior image quality with vibrant colors and better sharpness.

OLED Displays

- OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight). OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even roll-able and stretchable in the future. OLEDs represent the future of display technology!

Three-Dimensional Viewing Devices

Graphics monitors for the display of three-dimensional scenes have been devised using a technique that reflects a CRT image from a vibrating, flexible mirror. In this system when varifocal mirror vibrates it changes focal length. These vibrations are synchronized with the display of an object on a CRT so that each point on the object is reflected from the mirror into spatial position corresponding to the distance of that point from a specified viewing position. This allows user to walk around an object or scene and view it from different sides.



Virtual Reality Devices

Virtual reality system enables users to move and react in a computer-simulated environment. Various types of devices allow users to sense and manipulate virtual objects much as they would real objects. This natural style of interaction gives participants the feeling of being immersed in the simulated world. Virtual reality simulations differ from other computer simulations in that they require special interface devices that transmit the sights, sounds, and sensations of the simulated world to the user. These devices also record and send the speech and movements of the participants to the simulation program.

To see in the virtual world, the user wears a head-mounted display (HMD) with screens directed at each eye. Head mounted displays are used with headphones and hand controllers to provide a *fully immersive* experience. The HMD contains a position tracker to monitor the location of the user's head and the direction in which the user is looking. Using this information, a computer recalculates images of the virtual world to match the direction in which the user is looking and displays these images on the HMD.

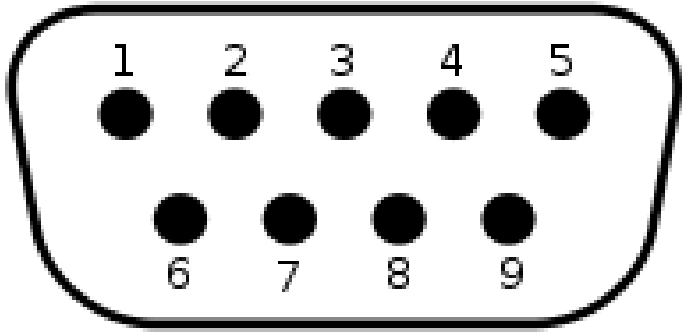
Graphics Card or Display Adapters

- A video card is typically an adapter, a removable expansion card in the PC.
- Thus, it can be replaced! A video display adapter which is the special printed circuit board that plugs into one of the several expansion slots present on the mother board of the computer.
- A video display adapter is simply referred as a video card. The video card can also be an integral part of the system board; this is the case in certain brands of PCs and is always the case in laptops and clear preference for the replaceable video card in some PCs.
- A number of display adapters are available with varying capabilities especially Intel systems support following adapters:

1. **Monochrome Adapter (MA)**
2. **Hercules Graphics Adapter (HA)**
3. **Color Graphics Adapter (CGA) → flicker**
4. **Enhanced Graphics Adapter (EGA) → no flicker**
5. **Multicolour Graphics Adapter (MCGA)**
6. **Video Graphics Adapter (VGA)**
7. **Super Video Graphics Adapter (SVGA)**
8. **Extended Graphics Adapter (XGA)**

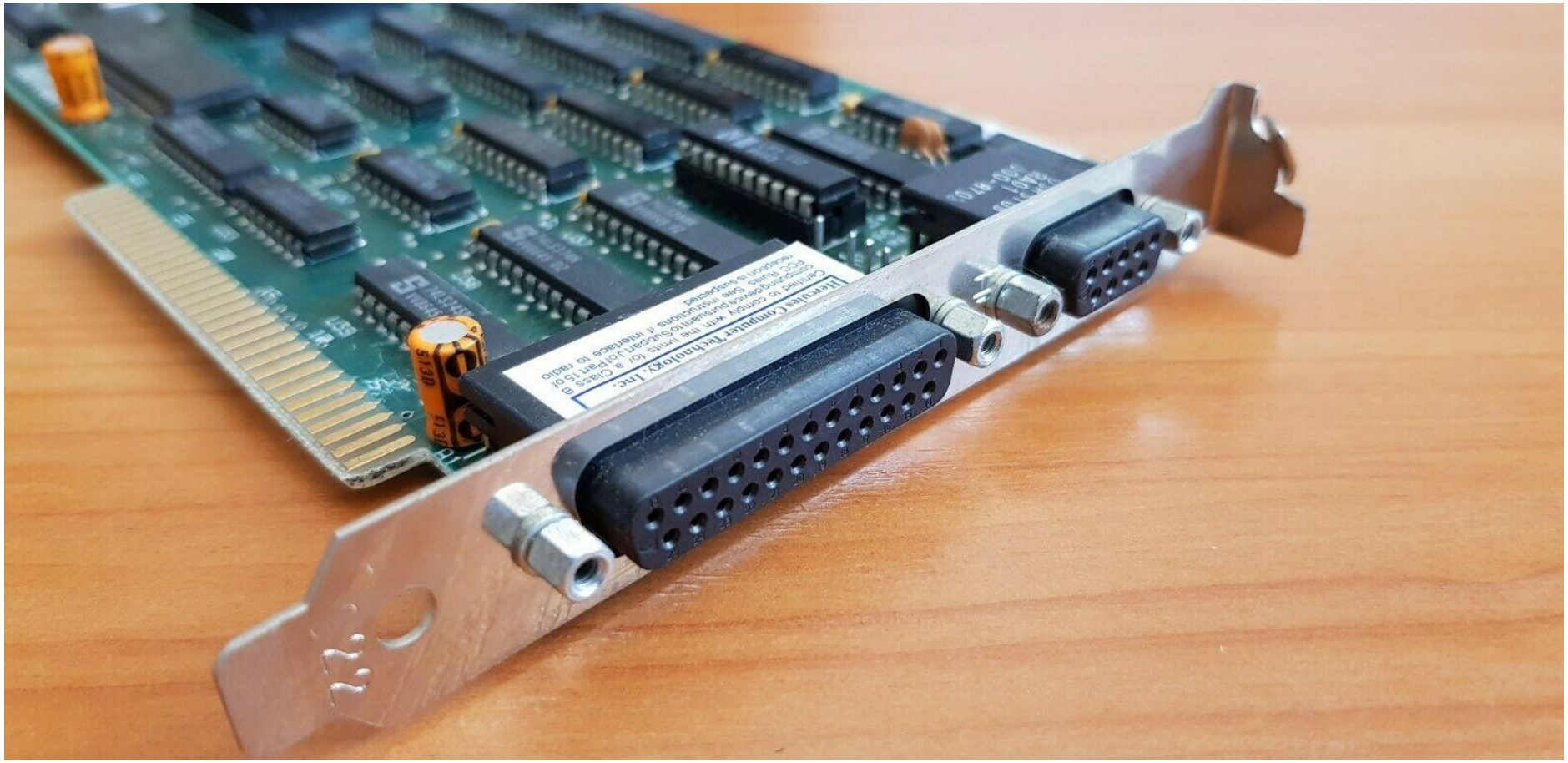
Monochrome Adapter (MA)

- The simplest and the **first** available adapter is MA.
- This adapter can **display only text** in single color and has no graphics displaying capability.
- Originally this drawback only prevented the users from playing video games.
- MA is no longer suitable, though it offers clarity and high resolution.



Hercules Graphics Adapter (HA)

- The Hercules card emulates the monochrome adapter but also operates in a graphics mode.
- Having graphics capabilities, the Hercules card became somewhat of a standard for monochrome systems.



Color Graphics Adapter (CGA)

- This adapter can **display text as well as graphics**. In text mode it operates in 25 rows by 80 column mode with 16 colors.
- One drawback of CGA card is that it **produces flicker and snow.**

Enhanced Graphics Adapter (EGA)

- The EGA could emulate most of the functions and all the display modes of CGA and MA.
- The EGA offered high resolution and was not plagued with the snow and flicker problems of CGA.
- In addition EGA is designed to use the enhanced color monitor capable of displaying 640x 350 in 16 colors from a palette of 64.

Multicolour Graphics Adapter (MCGA)

The MCGA was designed to emulate the CGA card and to maintain compatibility with all the CGA modes.

Video Graphics Adapter (VGA)

- The VGA supports all the display modes of MA, CGA and MCGA.

- In addition, VGA supports a graphics mode of 640 x 480 with 16 colors.

Super Video Graphics Adapter (SVGA)

The SVGA designation refers to enhancements to the VGA standard by independent vendors.

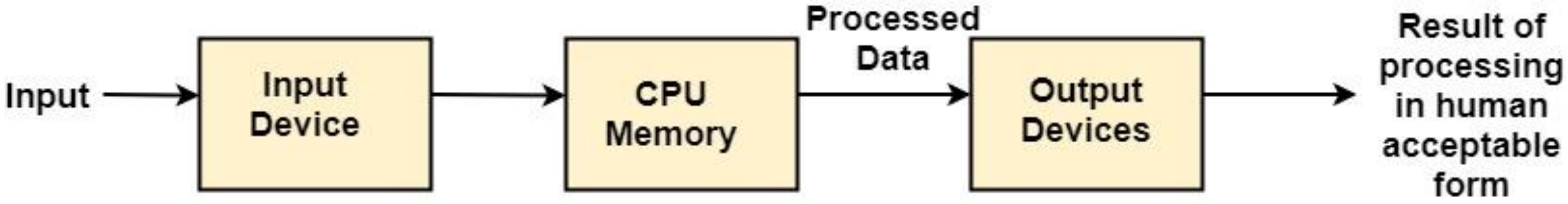
Each SVGA card has different capabilities, you need special device driver programs for driving them.

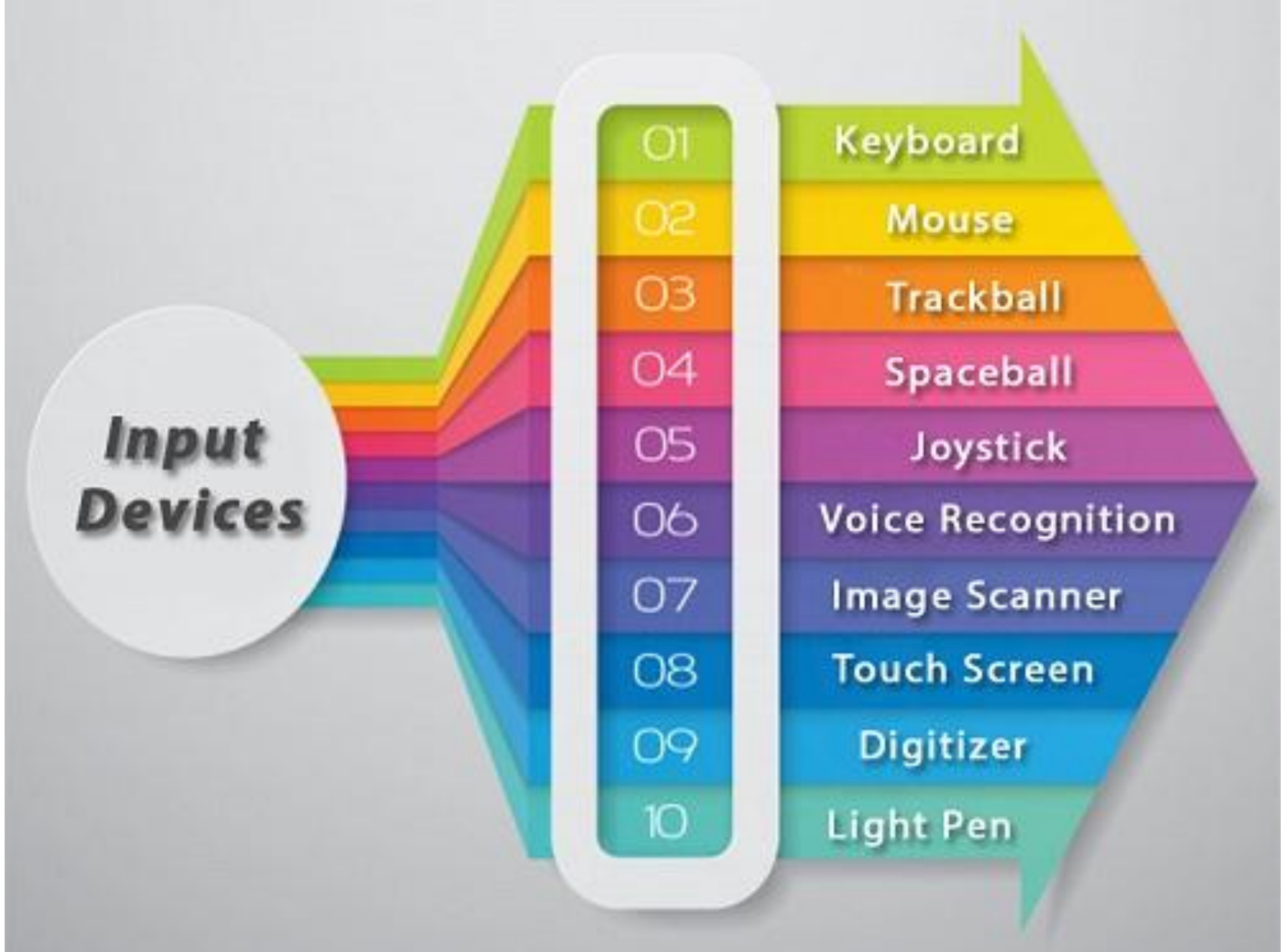
Extended Graphics Adapter (XGA)

- The XGA evolved from the VGA and provides greater resolution, more colors and much better performance. The XGA has a graphics processor bus mastering.
- Being a bus master adapter means that the XGA can take control of the system as though it were the mother board.

Input Devices

- The Input Devices are the hardware that is used to transfers input to the computer.
- The data can be in the form of text, graphics, sound, and video. Output device display data from the memory of the computer.
- Output can be numeric data, line, polygon, and other objects.




Input Devices
01 Keyboard
02 Mouse
03 Trackball
04 Spaceball
05 Joystick
06 Voice Recognition
07 Image Scanner
08 Touch Screen
09 Digitizer
10 Light Pen

Output Devices

- It is an electromechanical device, which accepts data from a computer and translates them into form of understandable by users.