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Computer Graphics 05101301

Prof. Hina Chokshi, Sr. Assistant Professor
Parul Institute of Computer Application - BCA

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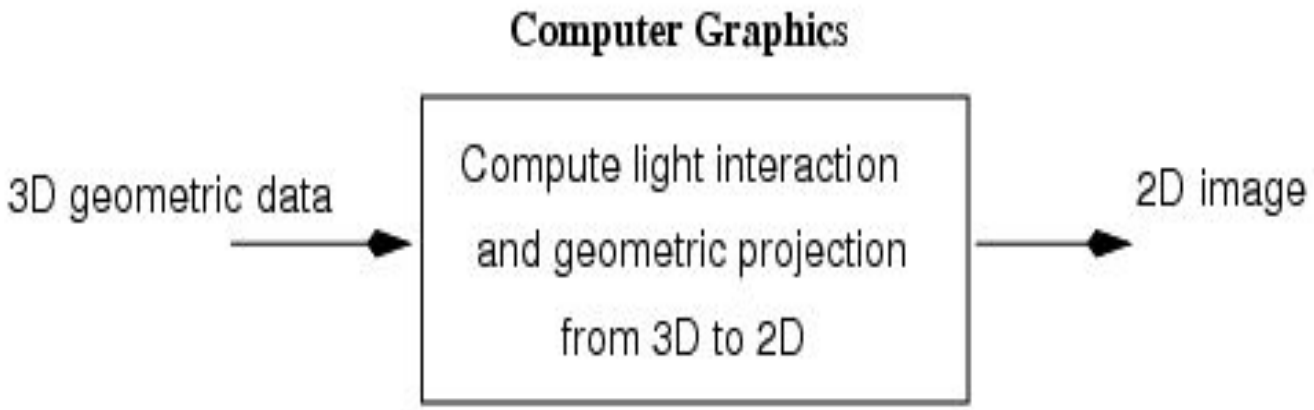
CHAPTER-1

Introduction to Computer Graphics

Computer Graphics

A field of study that deals with the pictures generated by a computer and the tools used to make and present them.



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History of Computer Graphics

1950 – Ben Laposky created the first graphics image

1987 – VGA (Video Graphics Array) was introduced (A standard connector used for computer video output)

1995 – 3D animated motion picture was developed.

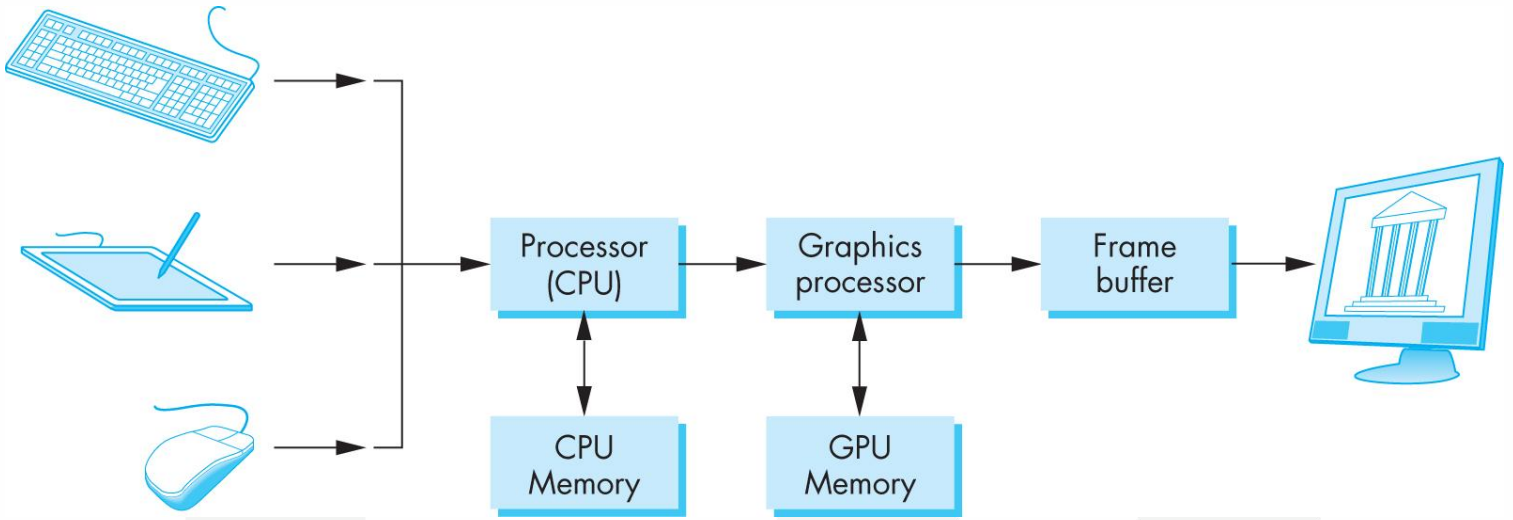
Introduction

- Computer graphics involves display, manipulation of data for proper visualization using computer.
- Generates 2D images of a 3D world represented in a computer.
- Main tasks:
  - ***Modeling***: creating and representing the geometry of objects in the 3D world
  - ***Rendering***: generating 2D images of the objects
  - ***Animation***: describing how objects change in time

Advantages of Computer Graphics

1. Information becomes more communicative when its represented graphically
2. A huge number of numbers may be replaced by a simple graph or chart diagram
3. Visual form of data may be more relevant to realize their characteristics
4. Creation of engineering designs and architectural blue-print may be fully automated
5. Mathematical models of hyperspace can be easily realized using computers
6. Using motion dynamics simulation experiments of moving objects can be performed

Basic Graphic System



Input devices

Output device

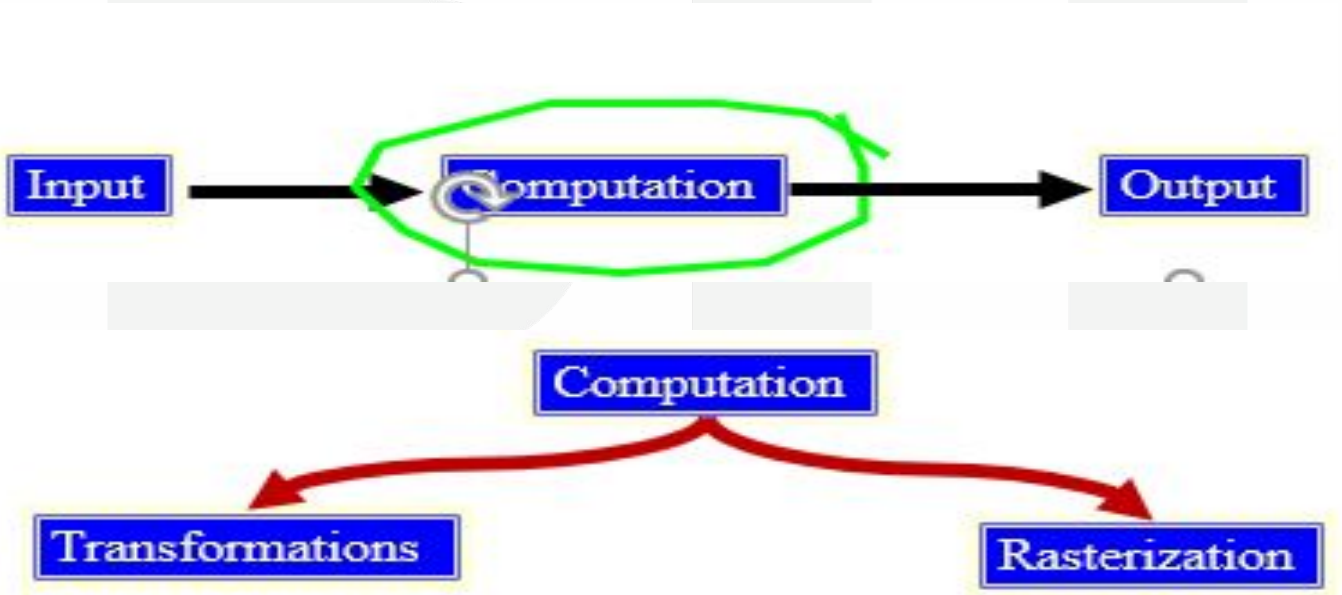
Image formed in frame buffer

Graphic System

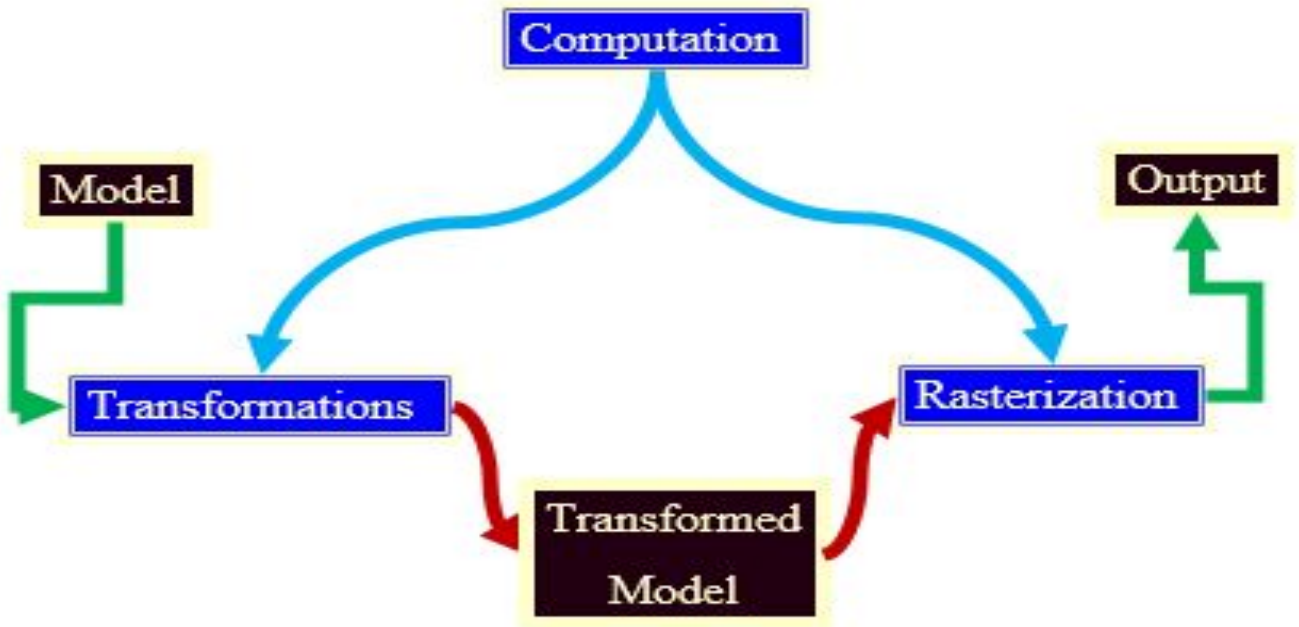
- Powerful processor to perform primitive graphical operations
- Memory (Frame buffer memory)
- Input devices eg. mouse, keyboard (trackball, joystick, etc)
- Output devices eg. , monitor, screen, audio (multiple screens, HMD, multiple speakers)
- A complete computer system consists of many components

Computation Stage

Now that we have a ***model*** of what we want to draw, what goes on inside the computer to generate the output?



Computation Stage



Frame Buffer and Pixel

Framebuffer - A block of memory, dedicated to graphics output, that holds the contents of what will be displayed.

Pixel - one element of the framebuffer

Frame buffer in Memory

If we want a framebuffer of 640 pixels by 480 pixles, we should allocate:

framebuffer = 640*480 bits

Bit Depth – Number of bits allocated per pixel in a buffer.

Bit depth

16 bits per pixel (high color)

5 bits for red, 5/6 bits for green, 5 bits for blue

potential of 32 reds, 32/64 green, 32 blues

total colors: 65536

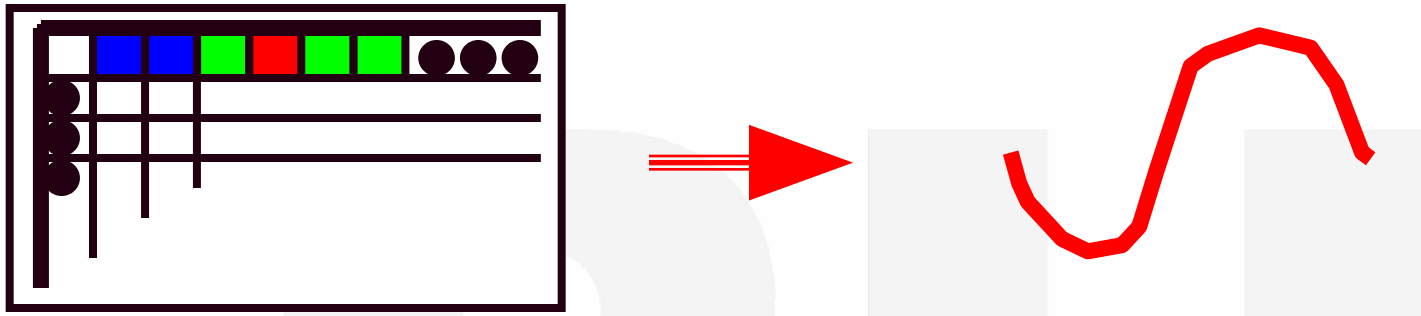
32 bits per pixel (true color)

8 bits for red, green, blue, and alpha

potential for 256 reds, greens, and blues

total colors: 16777216 (more than the eye can distinguish)

Framebuffer to Monitor



The values in the framebuffer are converted from a digital (1s and 0s representation, the bits) to an analog signal that goes out to the monitor.

Pixel

Pixel - The most basic addressable image element in a screen

CRT - Color triad (RGB phosphor dots)

LCD - Single color element

Screen Resolution - measure of number of pixels on a screen (m by n)

m - Horizontal screen resolution

n - Vertical screen resolution

Graphics Types

Vector Graphics

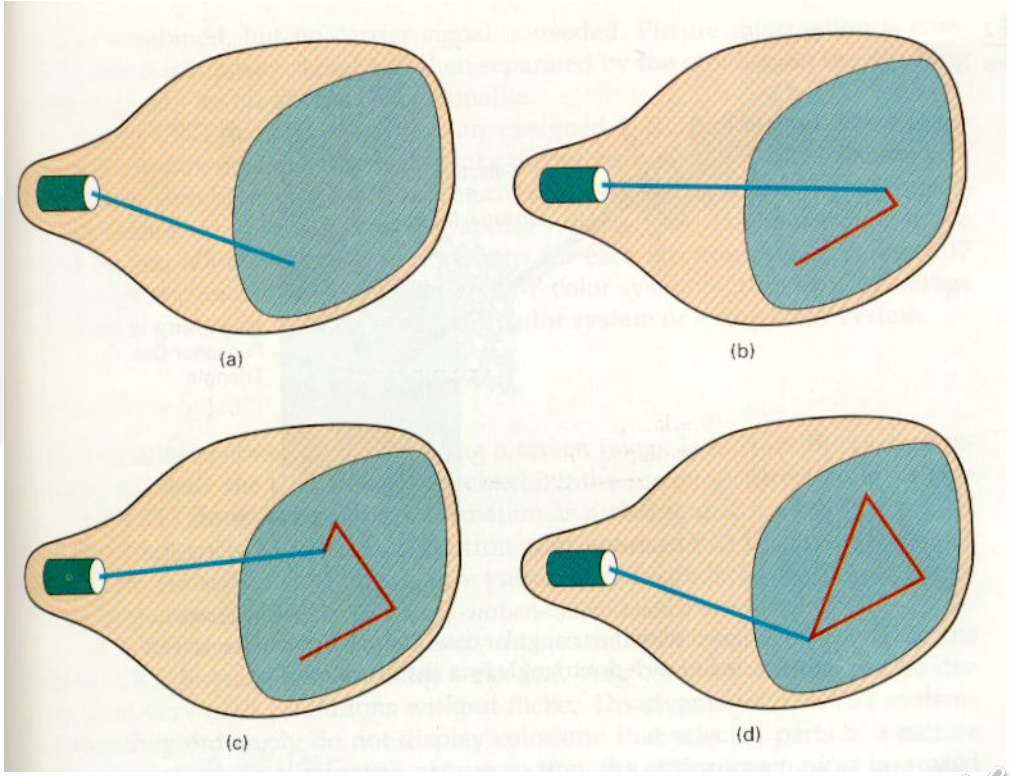
- Specify the content of the image using
  - Primitive shapes such points, lines, circles, etc.
  - Their size
  - Their positions
- Resolution independent
- Has to be translated into a raster image before displayed (rendering)
- OpenGL, SVG, PS, VRML, etc.

Raster Graphics

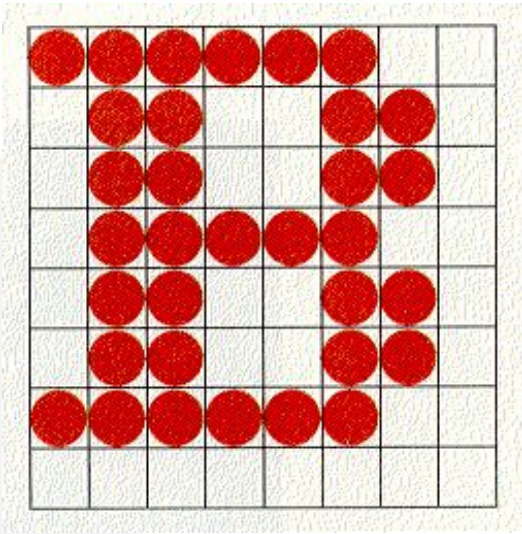
- Specify the content as a 2D array of pixels (picture elements)
- Resolution dependent
- Often provides rich details
- Bmp, gif, jpeg, etc.

Random Scan (Vector) Displays

- Vector stands for line.
- A set of line drawing instructions are stored in memory
- The electron beam is directed only to parts of the screen where the picture is to be drawn.



Raster Scan Displays



- Developed in the early seventies.
- It is today's dominant hardware technology. Almost all graphics systems are raster-based.
- A picture is produced as an array – the raster – of picture elements.
- This elements are called Pixels or Pels (Picture Elements). A pixel corresponds to a location, or small area, in the image.
- Collectively, the pixels are stored in a part of memory called the refresh buffer or frame buffer.

Refresh Rate

Definition: **The number of times per second the image is redrawn**.

The entire contents of the frame buffer are displayed on the CRT at a rate high enough to avoid **flicker.** This rate is called the refresh rate.

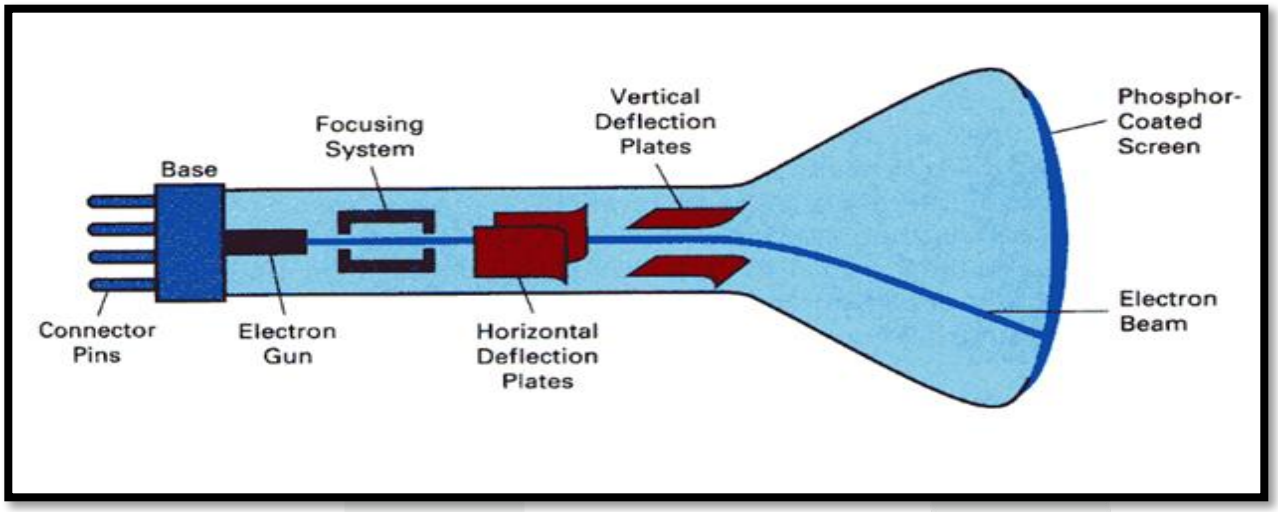
For a human to see a steady image on most CRT displays, the same path must be retraced, or refreshed, by the beam at least 60 times per second.

Refresh Rate

Current raster-scan displays perform refreshing at the rate of 60 to 80 frames per second, although some systems now have refresh rates of up to 120 frames per second.

Refresh rates are described in units of cycles per second, or Hertz (Hz), where a cycle corresponds to one frame (i.e. a refresh rate of 60 frames per second = 60 Hz).

Cathode Ray Tube



The cathode ray tube(CRT) is a vacuum tubecontaining anelectron gun(a source of electrons) and afluorescent screen, with internal or external means to accelerate and deflect the electron beam, used to create images in the form of light emitted from the fluorescent screen.

Features of CRT

The features of a CRT can be split into 4 main sections.

- Electron gun.
- Def lection system.
- Fluorescent screen.
- Glass Tube & Base.

Electron Gun

- The role of this section is to produce electrons at a high, fixed, velocity.
- This is done through a process known as thermionic emission.

Deflection System

- It consists of Two PERPENDICULAR sets of Electric/Magnetic fields.
- This allows control over both horizontal and vertical axes.
- By controlling the Voltage applied to the fields, it is possible to vary the deflection through Electrostatic force/Motor effect.

Fluorescent screen

- The role of this part is to display where the electrons are hitting the CRT.
- It is a screen coated with a material that emits light when struck by electrons.
- Zinc sulfide or Phosphorus are two commonly used materials.

Glass Tube and Base

- Glass tube is a long, clear tube. The CRT uses an evacuated glass envelope which is large, deep , fairly heavy, and relatively fragile.
- Inside the tube's neck is an assembly that produces a stream of electrons.
- Electrical connections to these internal components are made through metal pins that extend out through the back of the tube's neck, usually in a circular formation.
- Vacuum is created inside the glass tube.

How CRT work and display

- A CRT monitor contains millions of tiny red, green, and blue phosphor dots that glow when struck by an electron beam that travels across the screen to create a visible image.

- In a CRT monitor tube, the cathode is a heated filament.

- The heated filament is in a vacuum created inside a glass tube. The electrons are negative and the screen gives a positive charge so the screen glows.

How CRT work and display

- A CRT TV works by having the electron beam "scan" the screen at an rate faster than our eyes can perceive.

- The images we see are actually made from many fluorescent dots. The fluorescence caused by the beam striking the screen lasts a bit longer so that the next scan can be made without the previous image disappearing.

- It scans twice each time, first filling in the odd "holes" then the even ones. Each scan is about 1/50 of a second.

Application of CRT

- In televisions
- In computer monitors
- As a display device in radar
- In cathode ray oscilloscope

Advantages of CRT

- The cathode rayed tube can easily increase the monitor's brightness by reflecting the light.
- can produce more colours.
- The quality of the image displayed on a CRT monitors is superior to the LCD and Plasma monitors.
- The colour features of the cathode ray tube monitor are considered highly excellent.

Disadvantages of CRT

- Monitors causes a health hazard to the functioning of living cells.
- CRTs emit a small amount of X-ray radiation which can result in a health hazard.
- Constant refreshing of CRT monitors can result a headache.
- CRTs operate at very high voltage which can overheat system or result in an implosion.

Persistence

- Phosphorous are differentiated by their colour and persistence. Persistence means how long they continue to emit light on the screen persistence is defined as the time it takes the omitted light from the screen to decay to one 10th of the regional intensity.

- Low persistence phosphorus requires higher refresh rate to maintain a picture on the screen. Phosphorus with low persistence is useful for animation.

- A high persistence phosphorus use for displaying hi complex and static picture. Graphic monitors are constructed with persistence in the range of 10 to 60 us. But some phosphorus have a persistent greater than one second.

Resolution

- The maximum number of points that can be displayed without overlap on a CRT is referred to the Resolution. The resolution is the number of points per centimeter that can be plotted horizontally and vertically.
- Resolution of a monitor in our lab is 1048 *768
- Some of the monitors may have resolution of 1280×1024

Aspect ratio

- It is ratio of vertical points to the horizontal points necessary to produce equal length lines in both the direction on the screen.
- For example aspect ratio of 3/4 means vertical line plotted with three points on screen, has same length as horizontal line plotted with four points

Interlacing

- Scanning is always start from top left position of the screen, when it scans first line, the electron beam returns to the left side of the screen, that dress from right to left is known as the **horizontal retrace** of the electron beam.
- At the end of the each frame the electron beam returns to the top left corner of the screen to begin next frame is known as **vertical retrace.**
- Instead of displaying all lines, interlacing concept was used interlacing used to passes. In first pass, it displays all or lines and then in second part, it displays remaining even lines. So it displays all D's 60 frames in half of the time period.

Display methods of CRT

There are two methods which are used in CRT namely,

1) Raster scan display

2) Random scan display

1) Raster scan display

- This technology is similar to television technology here the electron beam continuously move up line by line from top to bottom.
- As the electron beam moves across each row, the beam intensity is turned on or off according to the requirement.
- Picture definition is stored in the memory area known as refresh buffer or frame buffer.

2) Random Scan Display

- It is also known as **Stroke writing** or C**alligraphic display** or **Vector display**.
- In random scan display, an electron beam is directed only to the parts of the screen where a picture is to be drawn.
- Random scan monitor draw only one line at a time, that's why it is known as vector display or/writing or calligraphic display.
- Refresh rate of random scam system depends on the number of lines to be displayed.

Color CRT monitor

CRT can display different colours by using a combination of phosphorus, which can produce different coloured lights on screen. By combining omitted light from the different phosphorus, a range of colours can be generated. These are two methods to produce colour on the screen.

1) Beam penetration method

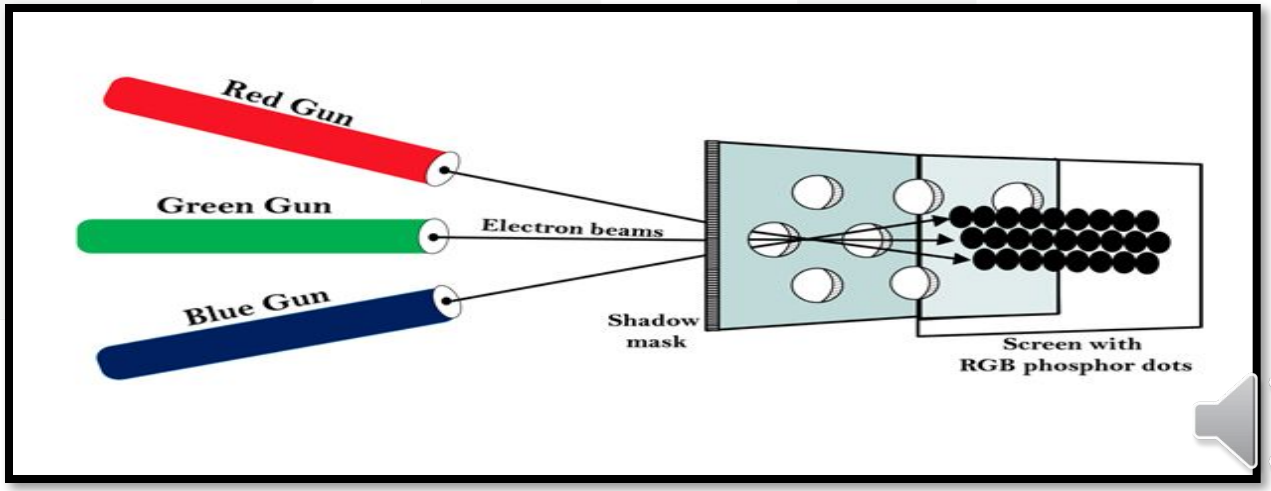
2) Shadow mask method

1) Beam penetration method

- It is used with random scan monitors. Two layers of phosphorus, red and green, or quoted on the inside of the CRT screen.
- If the beam content slow speed electrons, then the outer red layer is excited. If the beam content past electrons, then the inner green layer is excited.
- If speed is medium, then we can get orange and yellow colours. The colour of screen depends on the speed of the electrons, that speed is controlled by beam accelerating voltage.
- **Advantage** : it is in expensive (cheap)
- **Disadvantage :** It produces only four colors namely red, green, orange and yellow, so picture quality is also not good

2) Shadow mask method

- It is used in the systems like television.
- It produces wide range of colors compare to the beam penetration method.
- There are three phosphorus colored dots at each pixel of the screen.
- One phosphorus emits a red light, another emits green light and the third emits a blue light



Shadow mask method

- A shadow Mask grid is just behind the screen. There are three electron gun is one for each colour, to produce red, green and blue colours. The electron beams are passed through the shadow mask. Different colours can be produced by different intensity of the beam from all the guns.
- Colour CRT is in graphic systems are designed as RGB monitors. This monitors are using shadow mask methods and take the intensity level for such electron gun that is RGB directly from the computer system without any intermediate.

Direct view storage tubes

- Direct view storage tubes are used for maintaining picture on the screen and to refresh screen frequently. It stores the picture information as a charge distribution just behind the phosphorus quoted screen. Two electron guns are used in DVST. One is the primary gun, used to store the picture Pattern.

- **Advantage**: here refreshing is not required and thus, we can show high resolution images without any Flickr.

- **Disadvantage**: It do not display color. The selected portion of the image cannot be erased and the modified picture has to be redrawn. The erasing and re-drawing process can take several seconds for complex picture, because of all these reasons raster systems are more popular.

Flat Panel Displays

Graphic monitors are constructed with

1**) CRT**

2) Flat panel

1) Flat panel display:

- It is a class of video devices that have reduced volume, weight and power requirements compared to a CRT.
- It is thinner than CRT, and we can hang them on walls or wear them on our wrists. This technology is used in pocket notepads, small TV, monitors, calculator, pocket video games, laptop, computers
- Flat panel displays are categorised into two categories namely:

Flat Panel Displays

1) **Emissive Displays (Emitters): -** Emissive display are those which convert electrical energy to light. Eg 1. Plasma Panel Display 2. LED (Light Emitting Diode) 3. Thin Electroluminescent Devices.

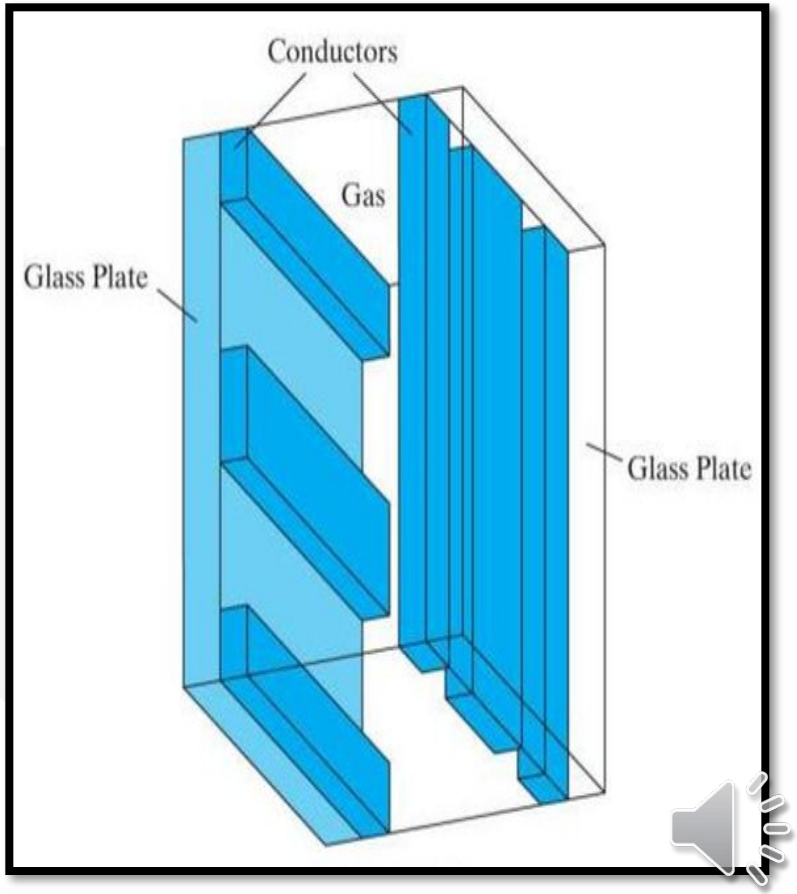
These device converts electrical energy into light for example plasma panels, thin film electroluminescent displays, light emitting diode (LED).

2) **Non Emissive Displays (Non-Emitters): -** Non Emissive use optional effects to convert sun light or light from any other sources to graphical pattern for example LCD (Liquid Crystal Display). These devices uses optical effects to convert sunlight or light from another source into graphic patterns. Example liquid crystal device LCD

Applications of emissive devices

1) Plasma Panel (Gas discharge display)

- It is constructed by using two glass plates and the region between two glass plates are filled by a mixture of gases that usually includes neon.
- A series of vertical ribbons is placed on one glass panel and a set of horizontal ribbons is built into the other glass panel.



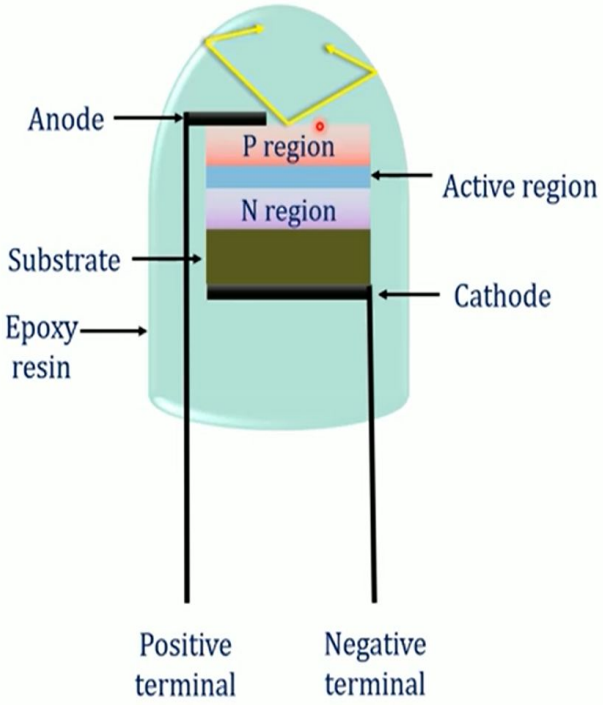
Plasma Panel

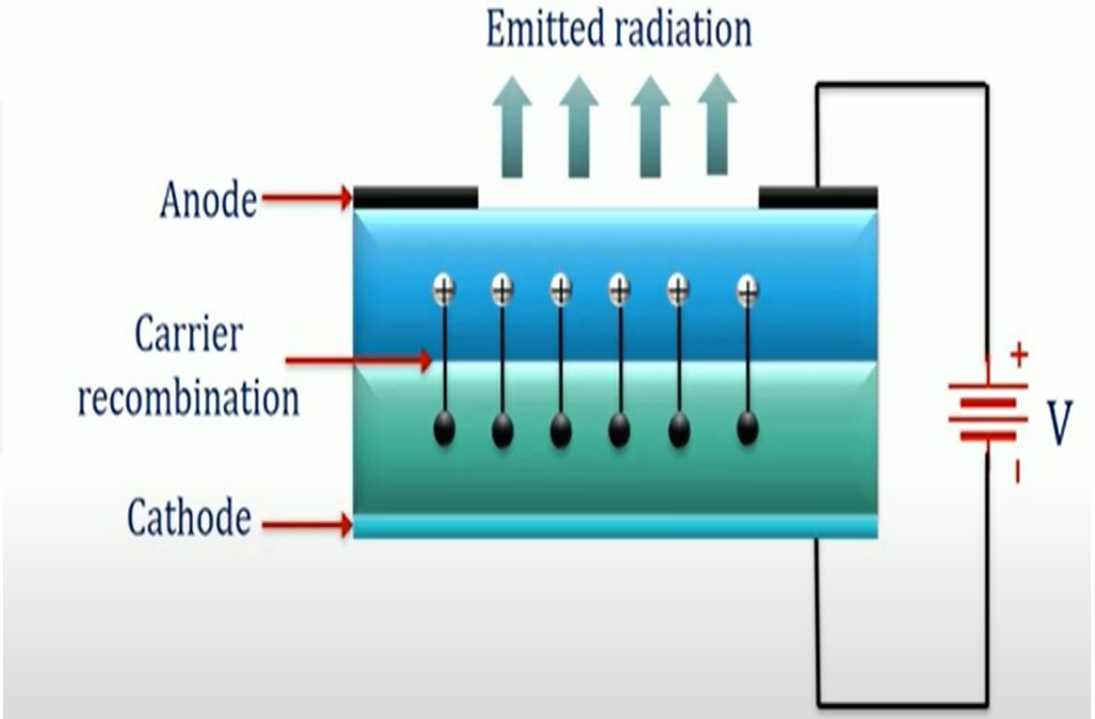
- When the firing voltage is applied to a pair of horizontal and vertical conductors, the gas at the intersection point starts glowing the electrons and the ions of the plasma.
- Picture definition is stored in a refresh buffer and the firing voltage applied to refresh pixel positions.
- It refresh the screen 60 times per second. Initially, plasma panel displayed only black and white colour but now it is capable of displaying colour and grey scale. The alternating current method is used to provide faster application of firing voltage and brighter display.

2) Light Emitting Diode (LED)

- A matrix of diodes is arranged to form the pixel positions in the display.
- And picture information is stored in a refresh buffer.
- Similar to CRT, information is read from the buffer and converted to voltage levels that are applied to the diodes to produce the light pattern in the display.

2) Light Emitting Diode (LED)

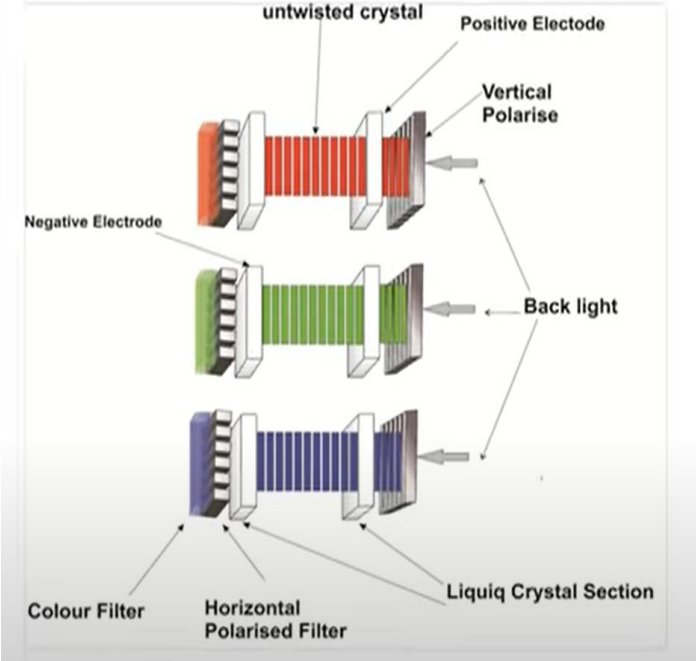


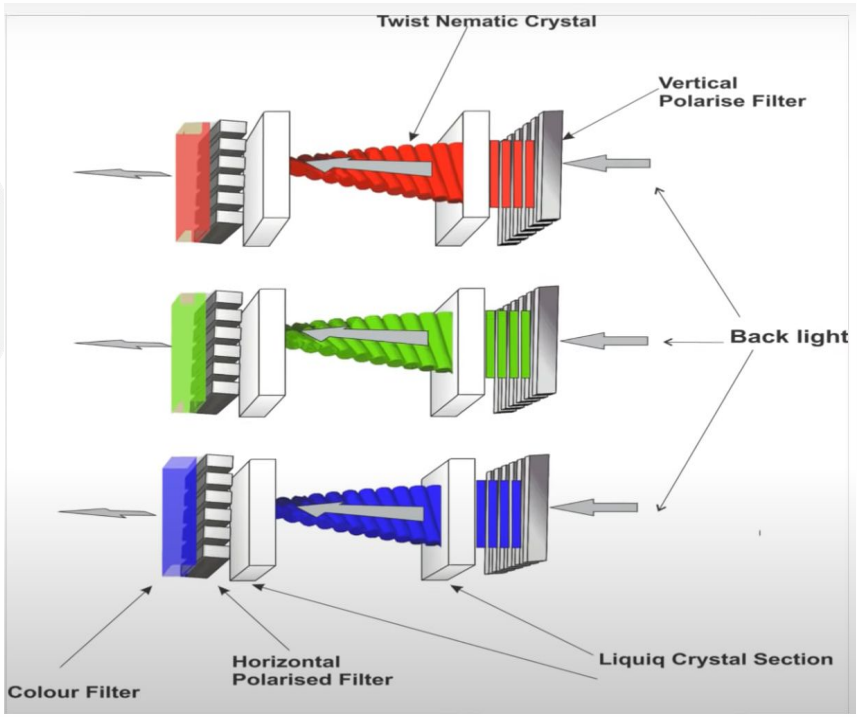


3) Liquid Crystal Displays(LCD)

- LCD are commonly used in small systems, such as calculators and portable laptop computers.
- It produces a picture by passing polarised light from the surroundings or from an internal light source through a liquid crystal material that can be aligned to either block or transferred the light.
- Known as liquid crystal because these compounds have a crystal type arrangement of the molecules, which flew like a liquid.
- Flat panel displays commonly use pneumatic thread like liquid crystal compounds.

3) Liquid Crystal Displays(LCD)





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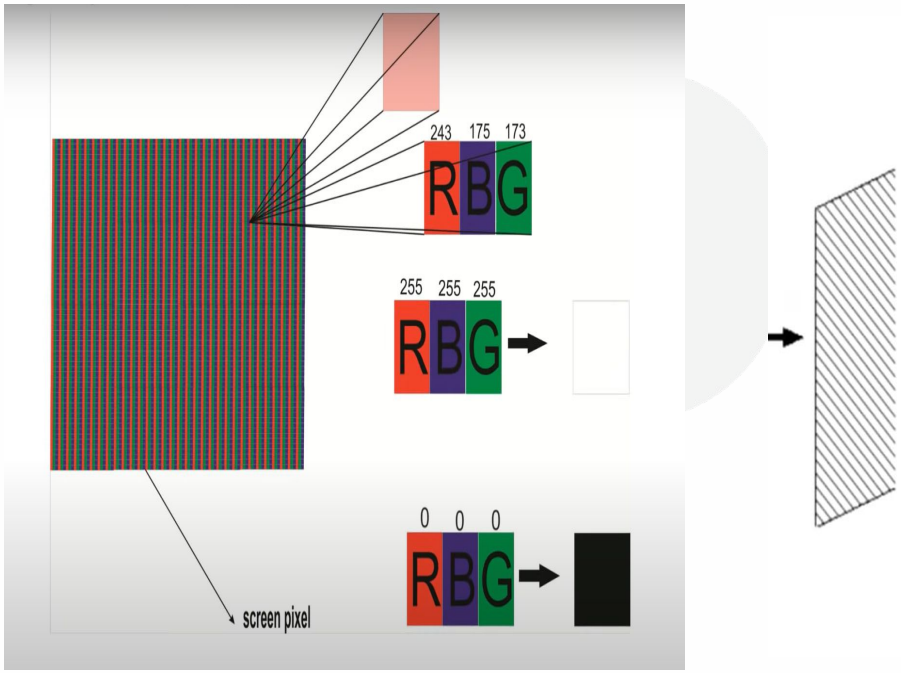

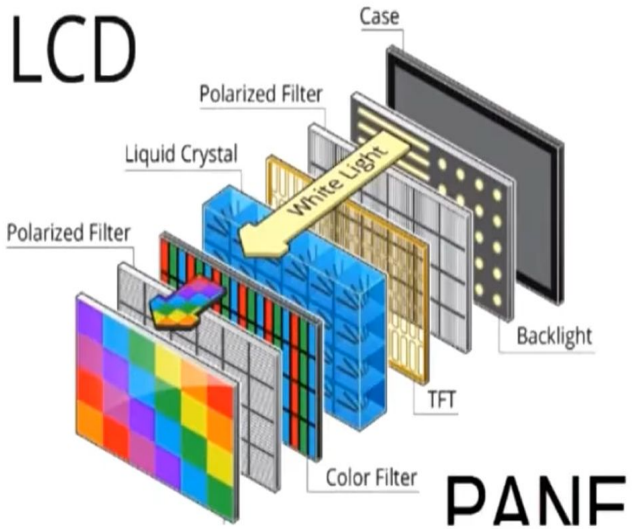

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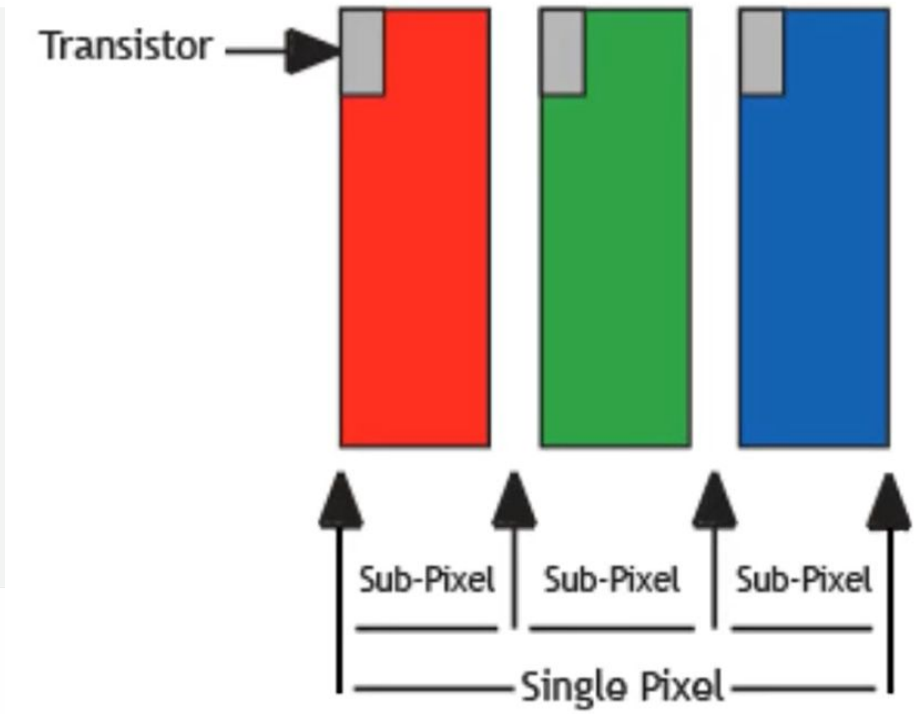

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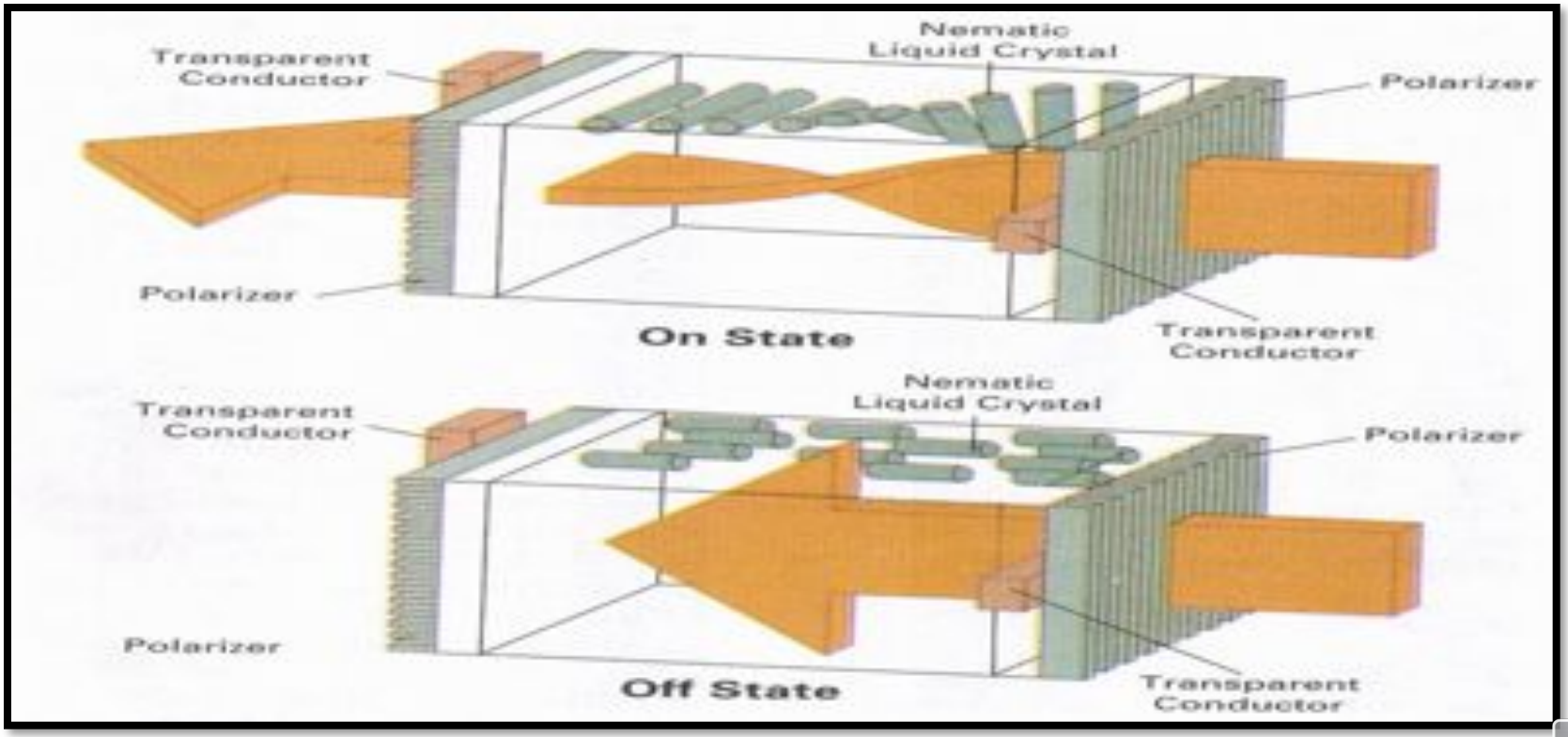

3) Liquid Crystal Displays(LCD)

- There are two glass plates, each containing a light polariser at right angles to the other plate, which sandwich the liquid crystal material.
- Rows of horizontal transparent conductors are built into one glass plate, and columns of vertical conductor are put into the other plate.
- The intersection of two conductors are present or defines a pixel position.

3) Liquid Crystal Displays(LCD)

1) **Passive Matrix LCD**

- In the **On- state condition**, polarise light passing through the material is twisted, so it will pass through the opposite polarised.
- For **Off-state condition**, the light passing through the metrics is twisted to pass through other polarising to turn off the voltage so that the light is not wasted. This type of device is known as **Passive Matrix LCD**.
- Here, picture definitions and stored in a refresh buffer and the screen is refreshed at the rate of 60 frames per second. Colours can be displayed by using different materials or dyes.

3) Liquid Crystal Displays(LCD)

Active matrix LCD

- In active matrix LCD, a transistor is placed at its pixel location, using thin film transistor technology.

- The transistors are used to control the voltage at the pixel locations and to prevent charge from leaking out of the liquid crystal cells.

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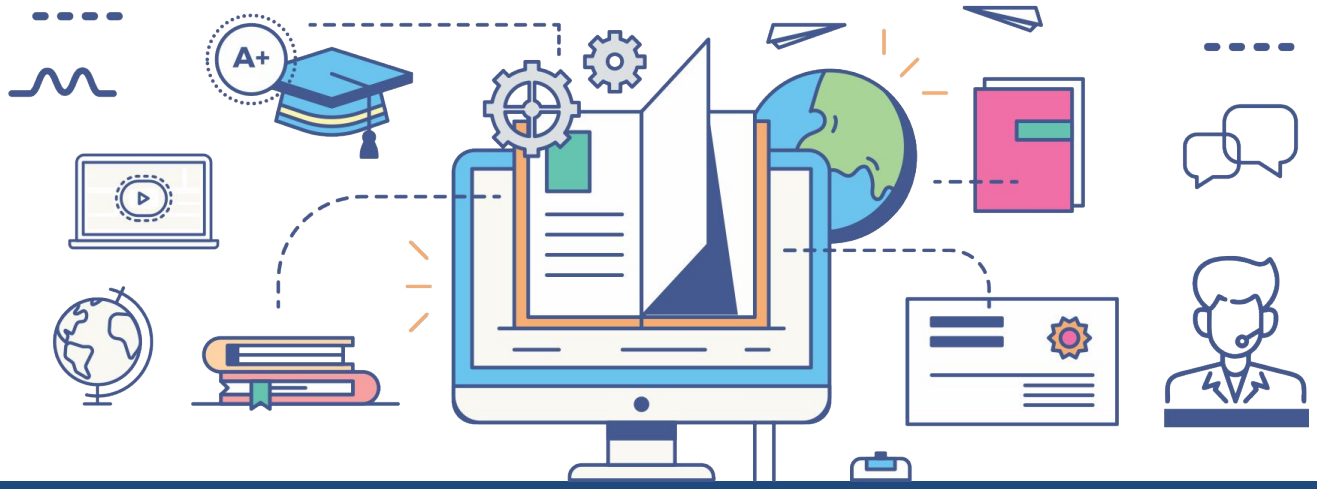

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