



# COMPUTER GRAPHICS

UNIT-1

# OUTLINE

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- ❖ Basic of Computer Graphics
- ❖ Applications of Computer Graphics
- ❖ Display devices
- ❖ Random and Raster Scan System
- ❖ Graphics Input Devices
- ❖ Graphics Software and Standards

# What is Computer Graphics ?

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- ❖ The computer graphics is one of the most effective and commonly used way to information in form of graphics object such as pictures, charts, graphs and diagram instead of simple text.
- ❖ Computer graphics is a process of generating, manipulating, storing and displaying graphics object. Ex: Such as pictures, charts, graphs, diagrams.

- ❖ Thus we can say that computer graphics makes it possible to express data in pictorial form.
- ❖ In computer graphics objects are presented as a collection of discrete picture elements.
- ❖ Picture Element = Pixel = Pel
- ❖ The pixel is the smallest screen elements.

- ❖ Graphics should be generated by controlling the pixel.
- ❖ The control is achieved by setting the intensity and colour of the pixel which compose screen.
- ❖ The process of determining the appropriate pixels for representing picture or graphics object is known as “rasterization”.
- ❖ The process of representing continuous picture or graphics object as a collection of discrete pixels is called “scan conversion”.

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What you can do with graphics before  
displaying it on screen?

- ✿ Graphics allows rotation, translation, scaling and performing various projections before displaying it.
- ✿ It also allows to add effects such as hidden surface removal, shading and transparency to the picture.
- ✿ User can edit (modify content, structure or appearance) graphics object with using keyboard, mouse or touch sensitive panel on the screen.
- ✿ There is close relationship between input devices and display devices.
- ✿ Graphics Devices = Input Devices + Display Devices

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# ADVANTAGES OF COMPUTER GRAPHICS

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- ❖ High quality graphics displays on PC
  - ❖ It provides tools for producing pictures
  - ❖ Produce animation using static image with computer graphics
  - ❖ Produce 1-D image in 2-D or 3-D using different simulators.
  - ❖ Using motion dynamics tool, user can make object stationary and the viewer moving around them.
  - ❖ Using update dynamics, it is possible to change the shape, colour or other properties of object.

# Presentation Graphics

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- ❖ In this application reports are generated on slides or transparencies.
- ❖ It is normally used to summarize financial, statistical, mathematical, scientific, and economics data for research.
- ❖ Graphs and charts can be in 3-D formats to make the presentation.

# Graphic User Interface

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- ✿ Major component of GUI interface is a window manager that allows a user to display multimedia window areas.
- ✿ Interface generally comes with a menu and icons for fast selection of processing options.
- ✿ Icon is a graphics symbol designed to look like a processing options.

# Auto-CAD

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- ❖ Use of computer graphics is in design process of engineering and architecture system.
- ❖ Auto cad applications are design to create building, automobiles, aircraft, spacecraft, textiles and more models.

# Tele-Medicine

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- ❖ In this application physician can consult with one another using video conferencing capabilities, where all can see the data and images, it brings together experts from a number of places in order to provide better care.
- ❖ Also used in bio-medical instrument like cardiogram, CT-Scan reports, X-ray.



# Virtual Reality

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- ❖ Virtual reality provides a very realistic effect using sight and sound, while allowing the user to interact with the virtual world.



# Computer Art

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- ✿ Computer graphics widely used in fine arts and commercial applications.
- ✿ Artist use a variety of applications like paint packages, mathematics packages, desktop publishing software and animation program.



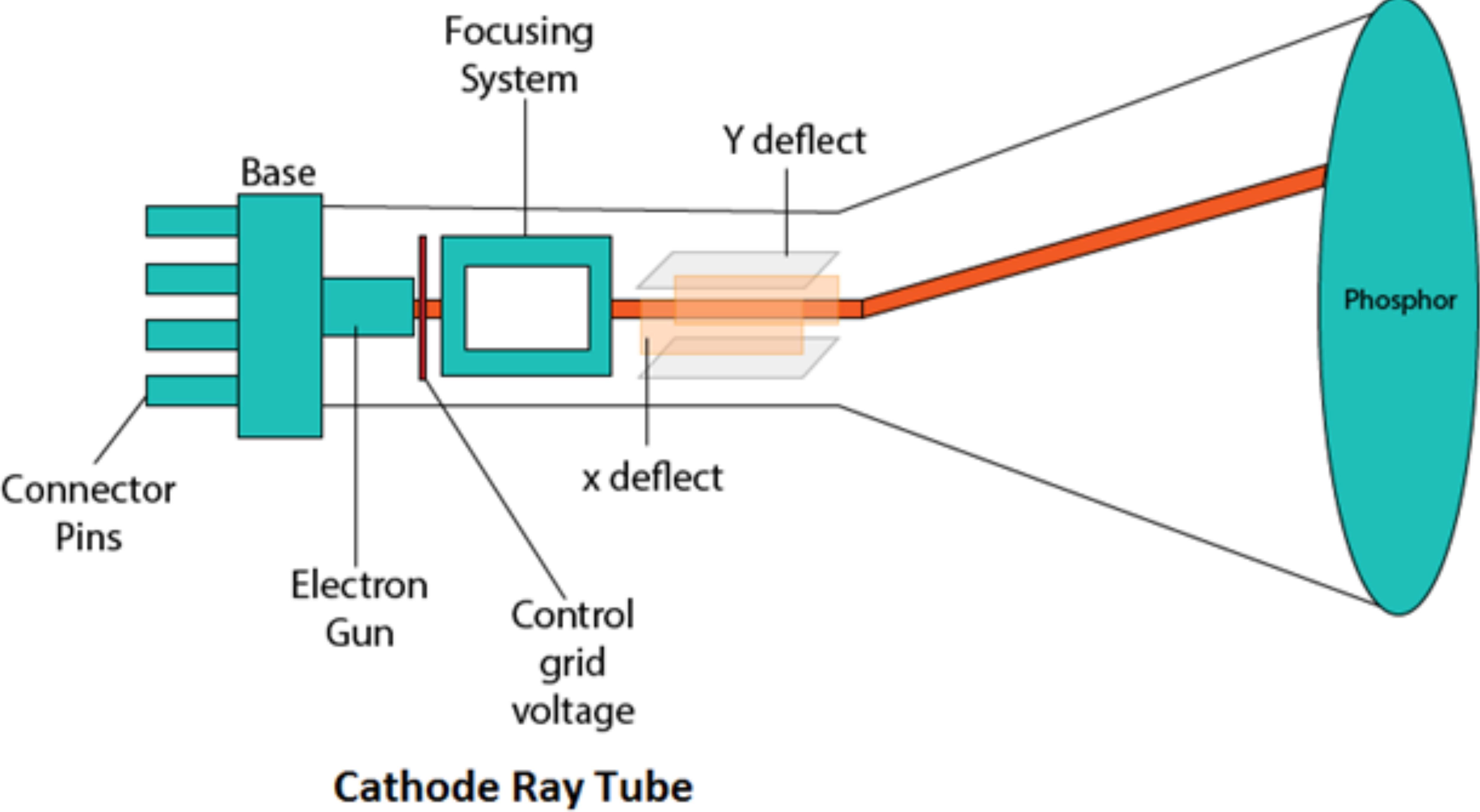
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# DISPLAY DEVICES

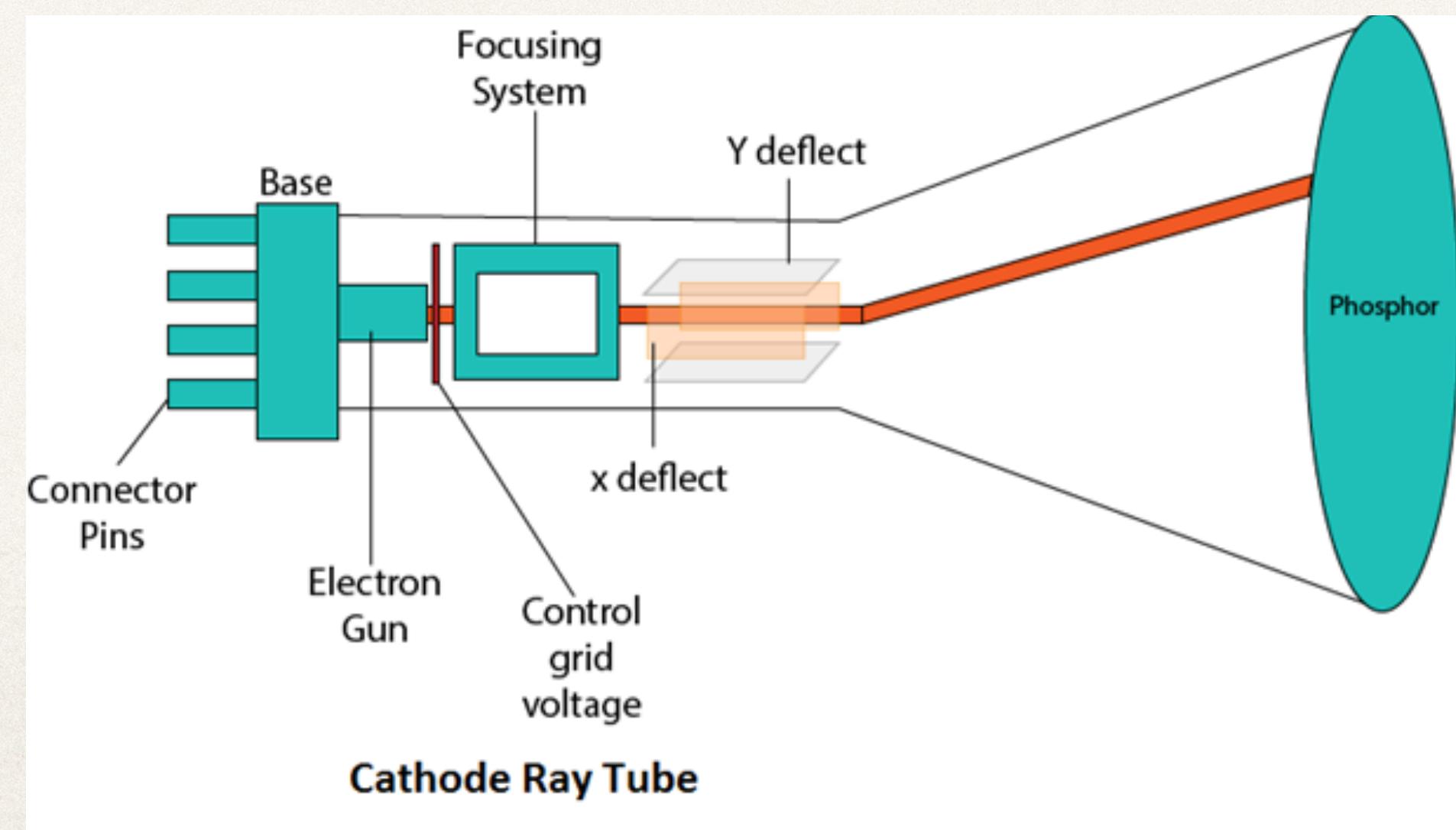
- ❖ Display devices also known as output devices.
- ❖ The most commonly used output devices in a graphics system is a video monitor.
- ❖ Types of display devices:
  - CRT
  - Radom Scan
  - Raster Scan
  - Colour CRT
  - DVST (Direct view storage)
  - Flat Panel Display
  - Plasma Panel Display
  - LCD

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# CRT (Cathode Ray Tube)



- ✿ CRT stands for Cathode Ray Tube. CRT is a technology used in traditional computer monitors and televisions. The image on CRT display is created by firing electrons from the back of the tube of phosphorus located towards the front of the screen.
- ✿ Once the electron heats the phosphorus, they light up, and they are projected on a screen. The color you view on the screen is produced by a blend of red, blue and green light.



# Main Components of CRT :

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- ✿ **Electron Gun:** Electron gun consisting of a series of elements, primarily a heating filament (heater) and a cathode. The electron gun creates a source of electrons which are focused into a narrow beam directed at the face of the CRT.
- ✿ **Control Electrode:** It is used to turn the electron beam on and off.
- ✿ **Focusing system:** It is used to create a clear picture by focusing the electrons into a narrow beam.

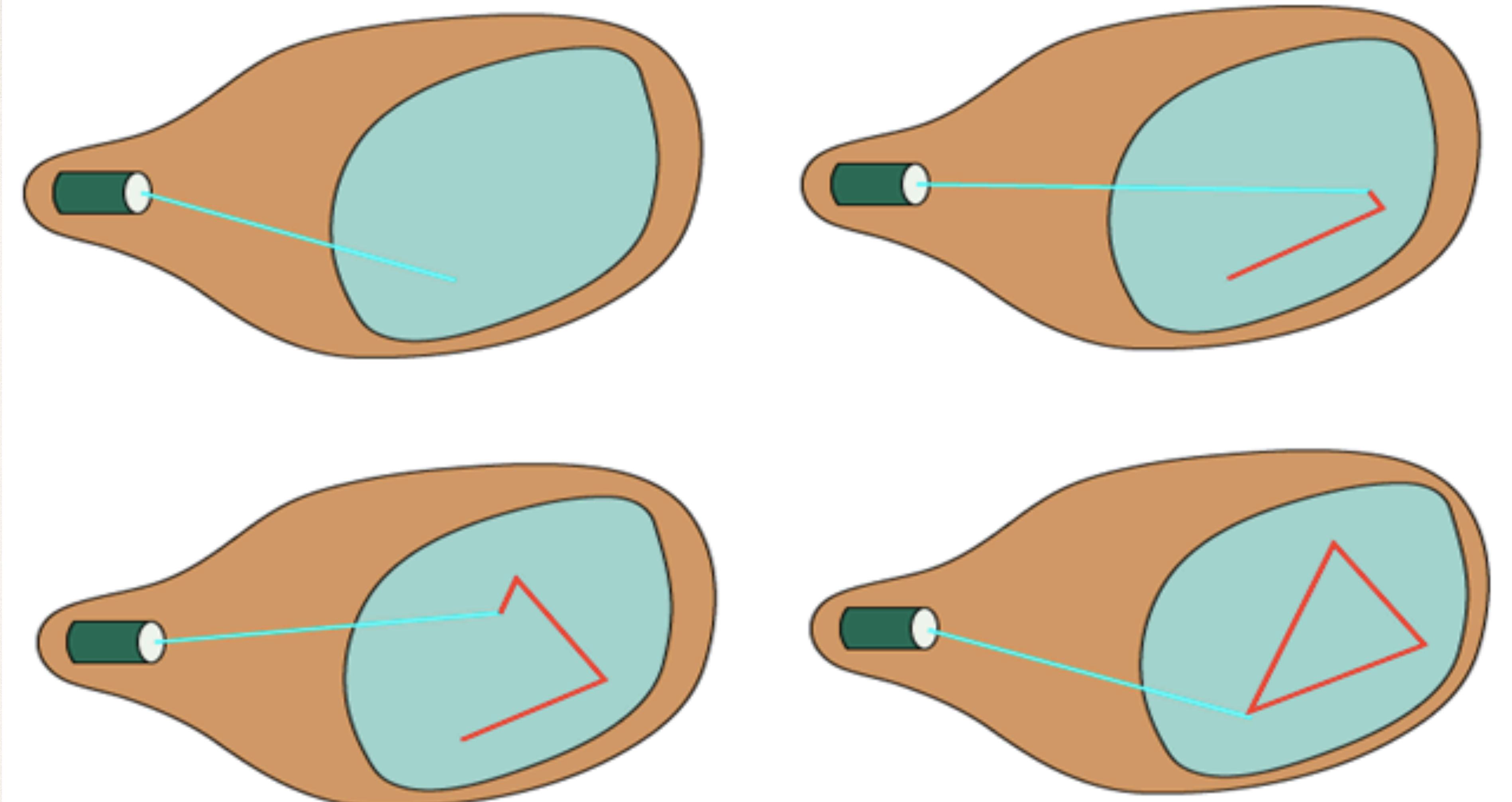
- ✿ **Deflection Yoke:** It is used to control the direction of the electron beam. It creates an electric or magnetic field which will bend the electron beam as it passes through the area. In a conventional CRT, the yoke is linked to a sweep or scan generator. The deflection yoke which is connected to the sweep generator creates a fluctuating electric or magnetic potential.
- ✿ **Phosphorus-coated screen:** The inside front surface of every CRT is coated with phosphors. Phosphors glow when a high-energy electron beam hits them. Phosphorescence is the term used to characterize the light given off by a phosphor after it has been exposed to an electron beam.
- ✿ The **control grid** voltage determines the velocity achieved by the electrons before they hit the phosphor.

- ✿ The deflection system of the CRT consists of two pairs of parallel plates, referred to as the **vertical** and **horizontal deflection plates**.
- ✿ The voltage applied to vertical deflection of the electron beam and voltage applied to the horizontal deflection plates controls the horizontal deflection of the electron beam.
- ✿ There are two techniques used for producing images on the CRT screen : **Random Scan (Vector scan)** and **Raster Scan**.

# Random Scan Display

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- ❖ Random Scan System uses an electron beam which operates like a pencil to create a line image on the CRT screen. The picture is constructed out of a sequence of straight-line segments.
- ❖ Each line segment is drawn on the screen by directing the beam to move from one point on the screen to the next, where its x & y coordinates define each point.
- ❖ After drawing the picture. The system cycles back to the first line and design all the lines of the image 30 to 60 time each second.(Shown in fig.)



- ✿ Random-scan monitors are also known as **vector displays** or **stroke-writing displays** or **calligraphic displays**.

❖ **Advantages:**

1. A CRT has the electron beam directed only to the parts of the screen where an image is to be drawn.
2. Produce smooth line drawings.
3. High Resolution

❖ **Disadvantages:**

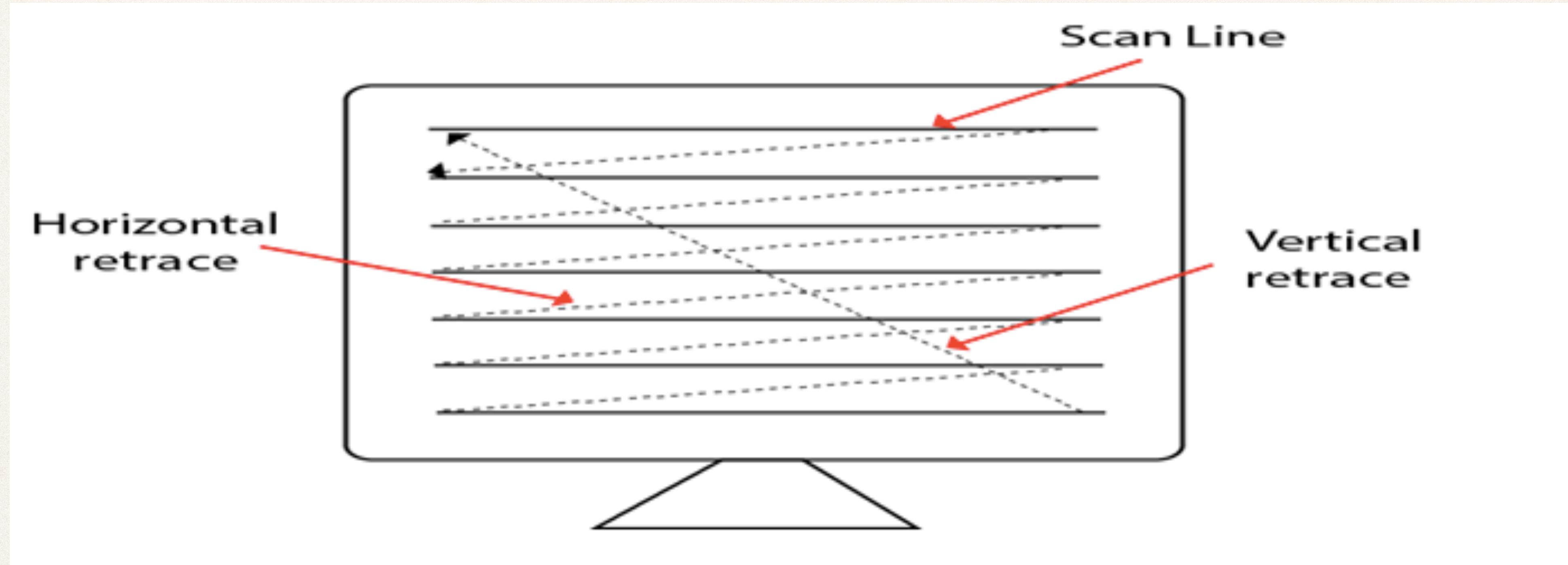
- Random-Scan monitors cannot display realistic shades scenes.
- Color limitation.

# Raster Scan Display

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- ❖ A Raster Scan Display is based on intensity control of pixels in the form of a rectangular box called Raster on the screen. Information of on and off pixels is stored in refresh buffer or Frame buffer. Televisions in our house are based on Raster Scan Method.
- ❖ 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 to 80 frames per second.
- ❖ Frame Buffer is also known as Raster or bit map. In Frame Buffer the positions are called picture elements or pixels. Beam refreshing is of two types. First is horizontal retracing and second is vertical retracing.

- When the beam starts from the top left corner and reaches the bottom right scale, it will again return to the top left side called at vertical retrace. Then it will again move horizontally from top to bottom called as horizontal retracing shown in fig:



# Types of Scanning or travelling of beam in Raster Scan :

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1. In *Interlaced scanning*, each horizontal line of the screen is traced from top to bottom. Due to which fading of display of object may occur. This problem can be solved by Non-Interlaced scanning. In this first of all odd numbered lines are traced or visited by an electron beam, then in the next circle, even number of lines are located.
2. For *non-interlaced* display refresh rate of 30 frames per second used. But it gives flickers. For interlaced display refresh rate of 60 frames per second is used.

❖ Advantages:

- Realistic image
- Million Different colours to be generated
- Shadow Scenes are possible.

❖ Disadvantages:

- Low Resolution
- Expensive

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# Difference between Random and Raster Scan display

**Random Scan**

1. It has high Resolution

2. It is more expensive

3. Any modification if needed is easy

4. Solid pattern is tough to fill

5. Refresh rate depends on resolution

6. Only screen with view on an area is displayed.

7. Beam Penetration technology come under it.

8. It does not use interlacing method.

9. It is restricted to line drawing applications

**Raster Scan**

1. Its resolution is low.

2. It is less expensive

3. Modification is tough

4. Solid pattern is easy to fill

5. Refresh rate does not depend on the picture.

6. Whole screen is scanned.

7. Shadow mark technology came under this.

8. It uses interlacing

9. It is suitable for realistic display.

# Color CRT Monitors

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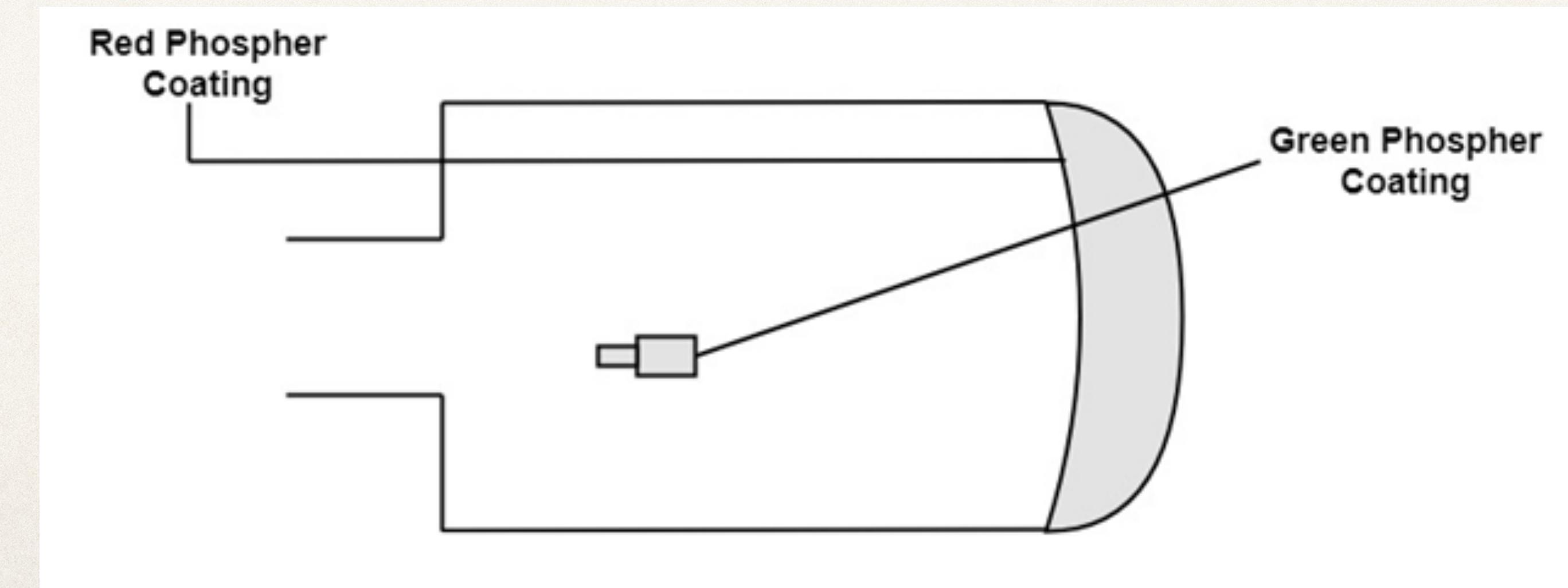
- ✿ The CRT Monitor display by using a combination of phosphors. The phosphors are different colours. There are two popular approaches for producing colour displays with a CRT are:
  1. Beam Penetration Method
  2. Shadow-Mask Method

# Beam Penetration Method

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- ❖ This technique is used with random-scan monitors.
- ❖ In this technique, the inside of CRT screen is coated with two layers of phosphor, usually red and green.
- ❖ The displayed colour depends on how far the electron beam penetrates into the phosphor layers.
- ❖ The outer layer is of red phosphor and inner layer is of green phosphor.

- ✳ A beam of slow electrons excites only the outer red layer.
- ✳ A beam of very fast electrons penetrates through the red layer and excites the inner green layer.
- ✳ At intermediate beam speeds, combination of red and green light are emitted and two additional colours, orange and yellow displayed.
- ✳ The beam acceleration voltage controls the speed of the electrons and hence the screen colour at any point on the screen.



❖ Advantages:

- Inexpensive

❖ Disadvantages:

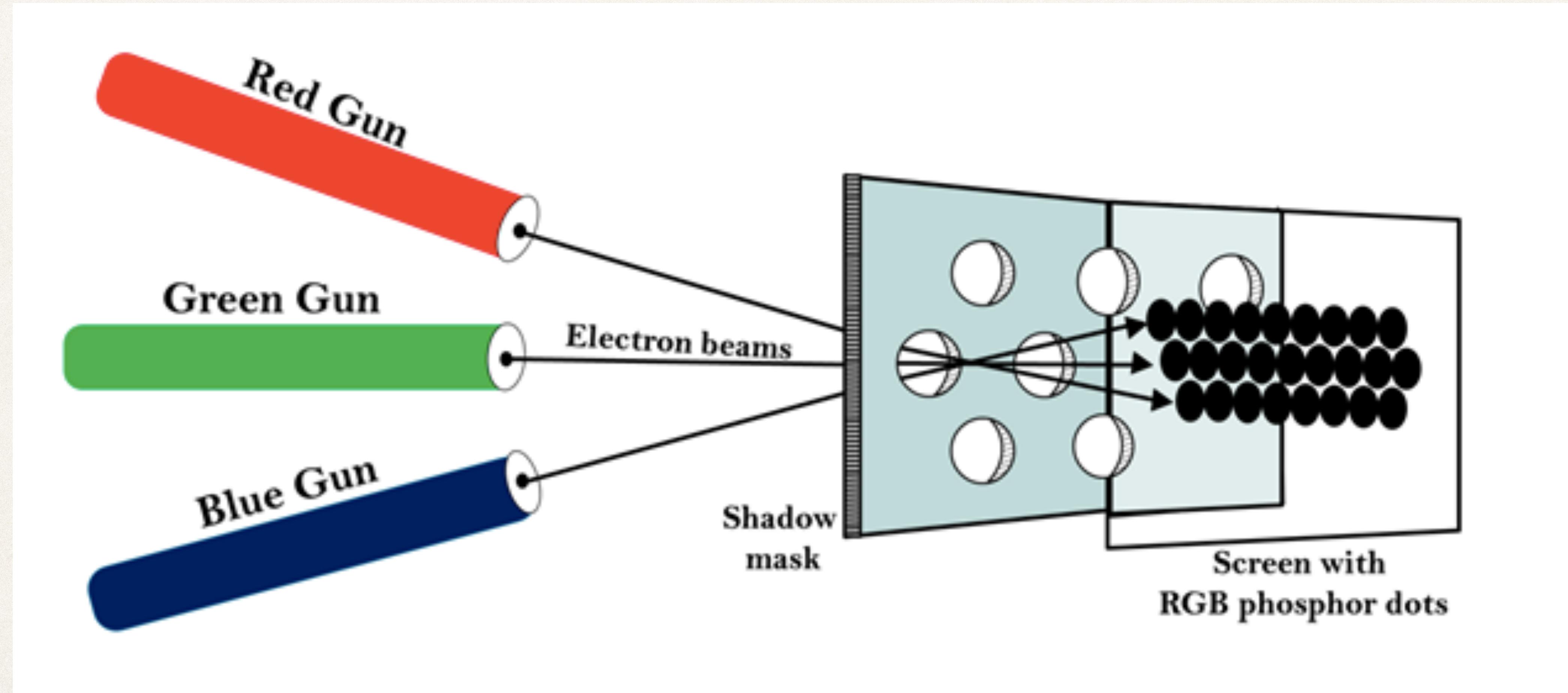
- Only four colors are possible
- Quality of pictures is not as good as with another method.

# Shadow Mask Method

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- ❖ The shadow mask technique produces a much wider range of colours than the beam penetration technique.
- ❖ Hence this technique is commonly used in raster-scan displays including colour TV.
- ❖ In a shadow mask technique, CRT has three phosphor colour dots at each pixel position.
- ❖ One phosphor dots emits a red light, another emits green light and third emits blue light.

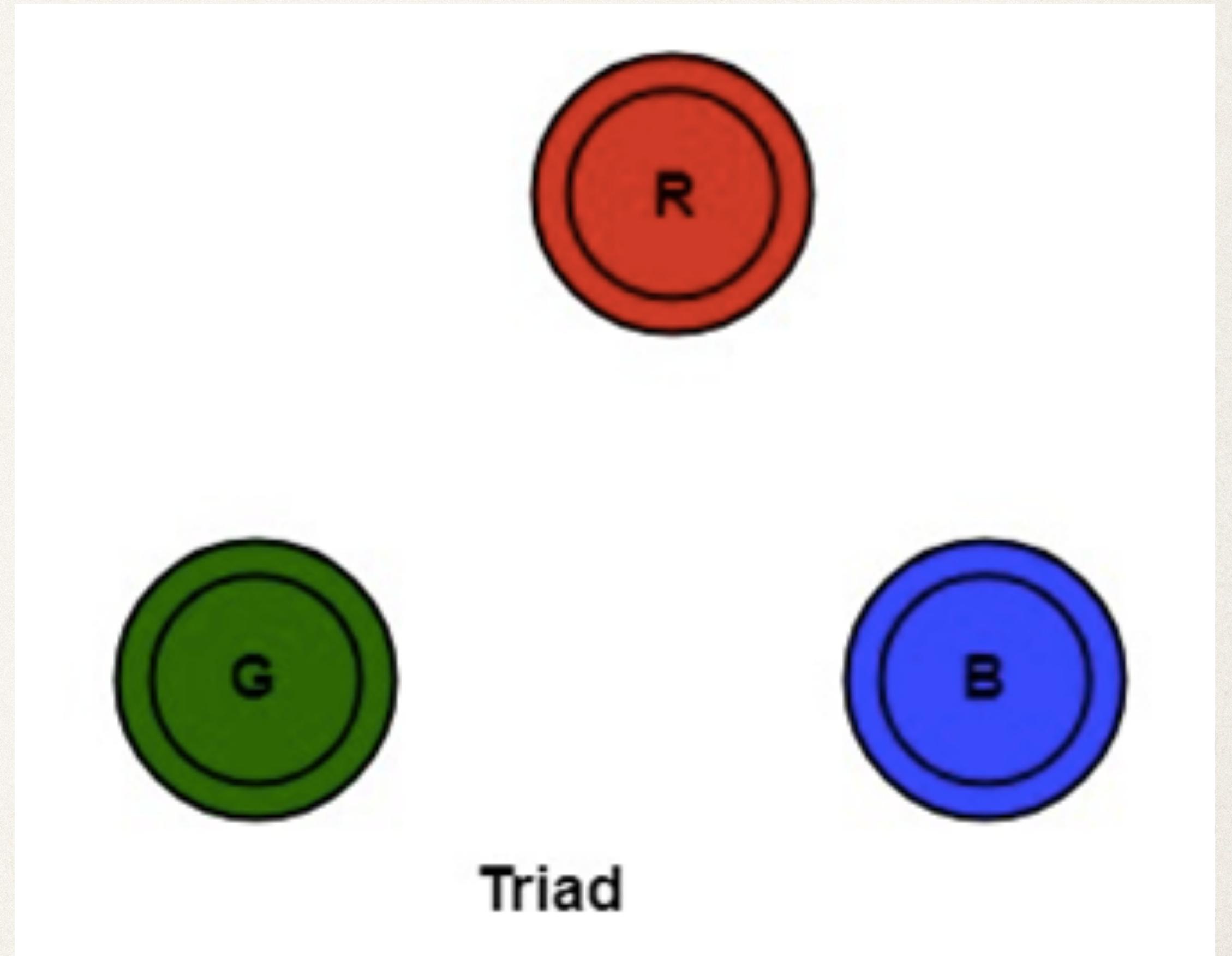
- This type of CRT has 3 electron guns, one for each color dot and a shadow mask grid just behind the phosphor coated screen.
- Shadow mask grid is pierced with small round holes in a triangular pattern.



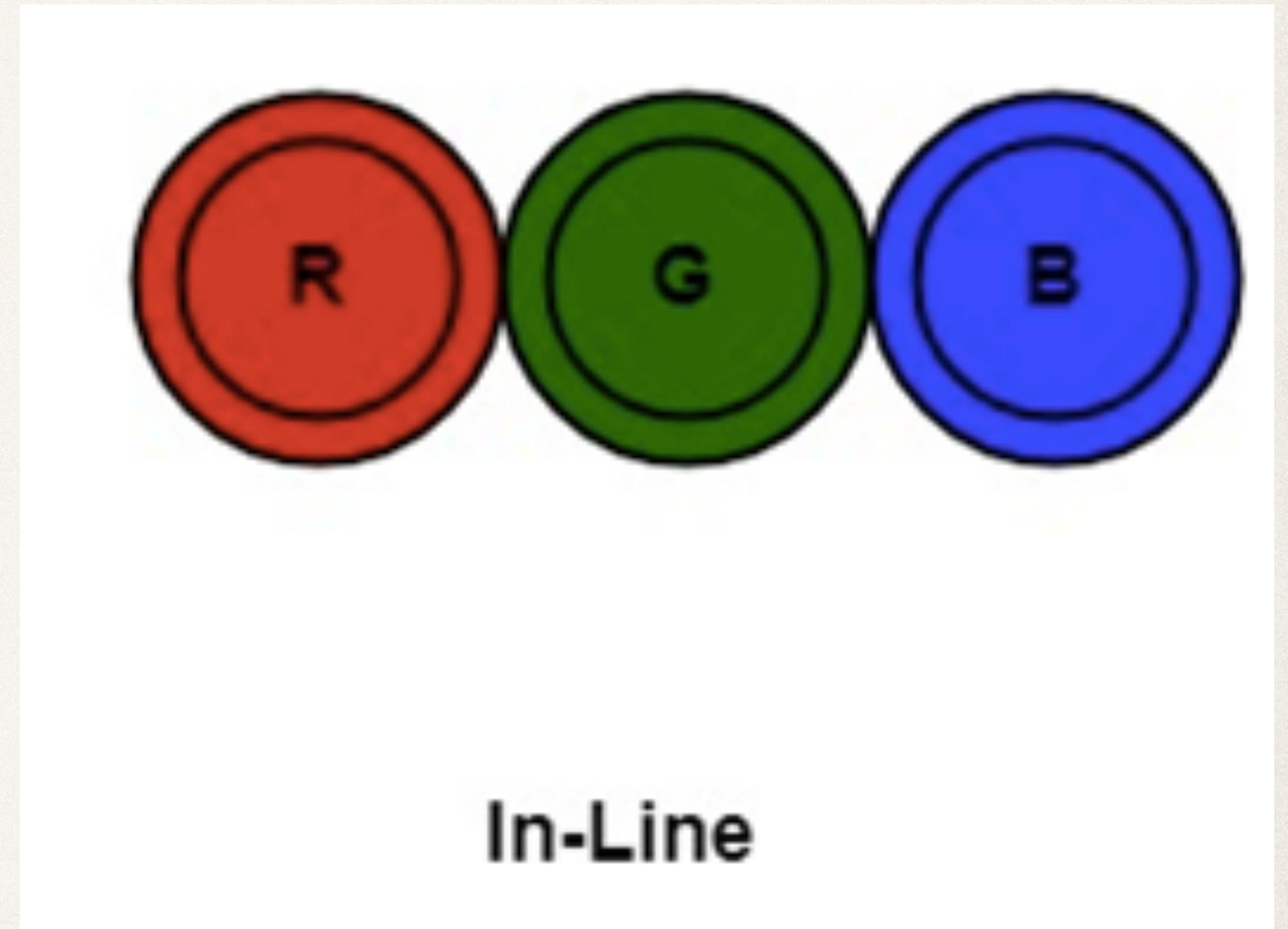
# Working

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- ❖ Triad arrangement of red, green, and blue guns.
- ❖ The deflection system of the CRT operates on all 3 electron beams simultaneously; the 3 electron beams are deflected and focused as a group onto the shadow mask, which contains a sequence of holes aligned with the phosphor-dot patterns.
- ❖ When the three beams pass through a hole in the shadow mask, they activate a dotted triangle, which occurs as a small color spot on the screen.
- ❖ The phosphor dots in the triangles are organized so that each electron beam can activate only its corresponding color dot when it passes through the shadow mask.



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- ❖ **Inline arrangement**: Another configuration for the 3 electron guns is an Inline arrangement in which the 3 electron guns and the corresponding red-green-blue color dots on the screen, are aligned along one scan line rather of in a triangular pattern.
  - ❖ This inline arrangement of electron guns is easier to keep in alignment and is commonly used in high-resolution color CRT's.



❖ **Advantage:**

- Realistic image
- Million different colors to be generated
- Shadow scenes are possible

❖ **Disadvantage:**

- Relatively expensive compared with the monochrome CRT.
- Relatively poor resolution
- Convergence Problem

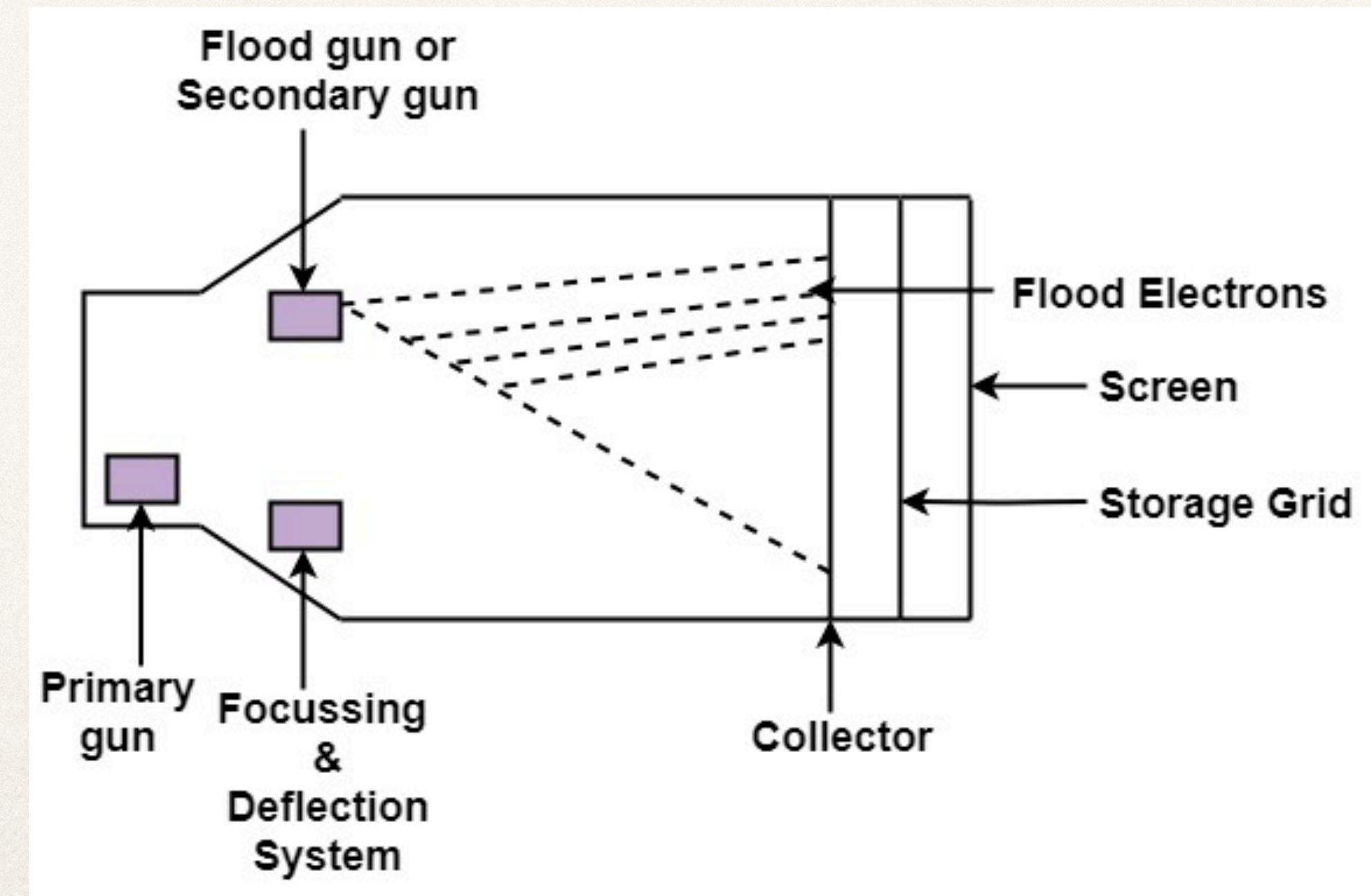
# Direct View Storage Tubes

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- ❖ DVST terminals also use the random scan approach to generate the image on the CRT screen.
- ❖ 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.
- ❖ In raster scan display we do refreshing of the screen to maintain a screen image.
- ❖ A DVST uses the storage grid which stores the picture information.

# Function of guns :

- \* Two guns are used in DVST
  - 1. Primary gun: It is used to store the picture pattern.
  - 2. Flood gun or Secondary gun: It is used to maintain picture display.



- ✿ A **primary gun** produces high speed electrons which strike on the storage grid to draw the picture pattern.
- ✿ Continuous low speed electrons from **flood gun** pass through the control grid and attracted to the positive charged areas of the storage grid.

❖ **Advantages :**

- Refreshing of CRT is not required.
- Complex picture can be displayed on high resolution.
- It has flat screen.

❖ **Disadvantages:**

- Erasing requires removal of charge on the storage grid.
- Selective or part erasing of screen is not possible.
- The performance of DSTV is poor in compare to CRT.
- Erasing of screen produces flash over the entire screen.

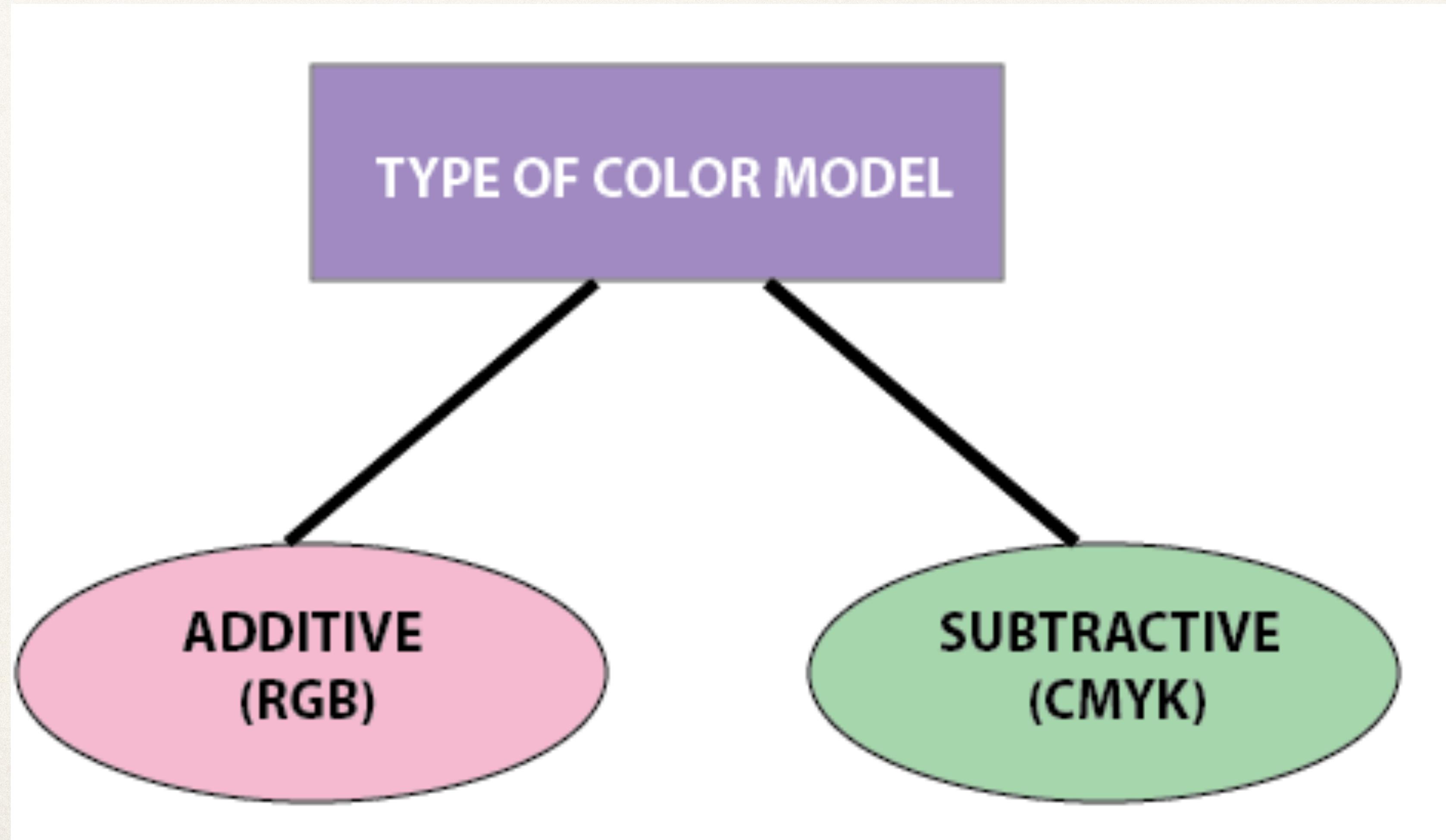
# Color Models

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- ❖ “Color model is a 3D color coordinate system to produce all range of color through the primary color set.”
- ❖ There are millions of colors used in computer graphics. The light displays the color. A Color model is a hierarchical system in which we can create every color by using RGB (Red, Green, Blue) and CMYK (Cyan, Magenta, Yellow, Black) models. We can use different colors for various purposes.
- ❖ The total number of colors displayed by the monitor depends on the storage capacity of the video controller card.
- ❖ The Video controller card is used as an interface between the computer system and the display device. It is also known as “Video Random Access Memory (VRAM).”

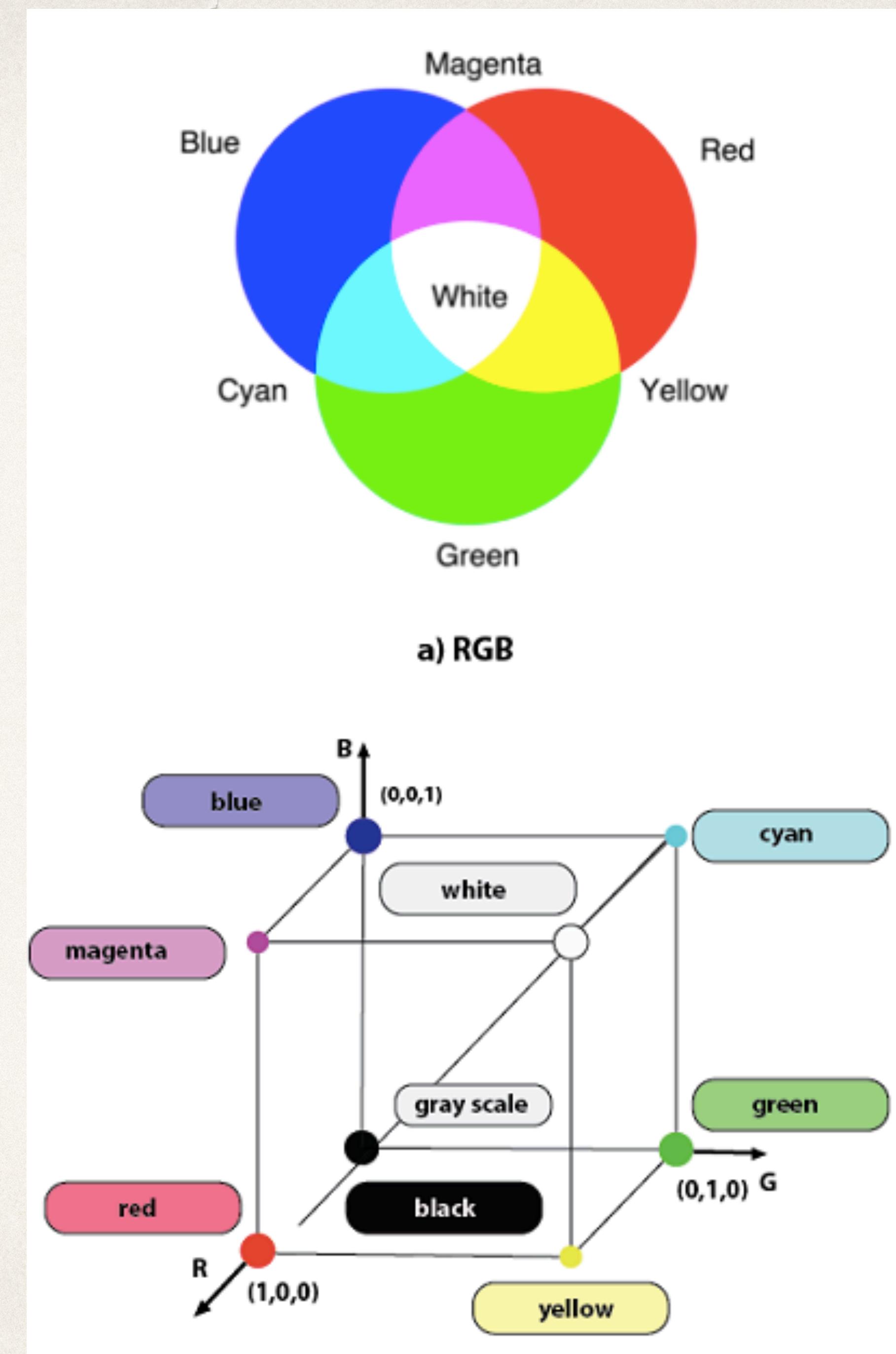
# Types :

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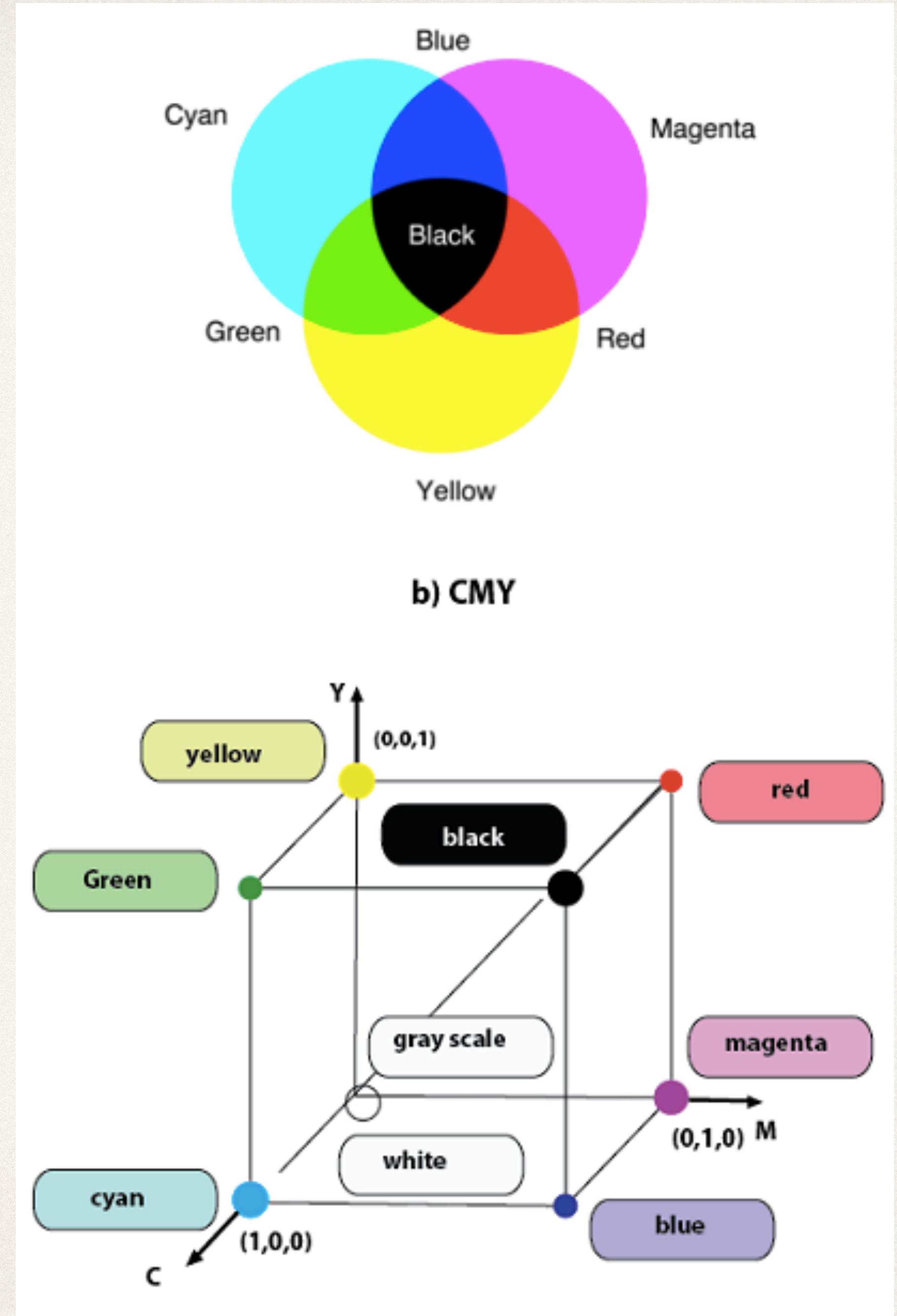
# Additive Color Model

- ❖ It is also named as “**RGB model.**” RGB stands for **Red, Green, Blue.** The Additive color model uses a mixture of light to display colors. The perceived color depends on the transmission of light. It is used in digital media.
- ❖ **For Example-** Computer Monitor, Television etc.



# Subtractive Color Model

- It is also named as “CMYK Model.” CMYK stands for **Cyan, Magenta, Yellow, and Black**. The Subtractive model uses a reflection of light to display the colors. The perceived color depends on the reflection of light.
- The CMYK model uses printing inks.
- **For Example—** Paint, Pigments, and color filter etc.



❖ **Advantages:**

- Easy to Implement.
- It uses color space for applications.
- No transformation for data display.

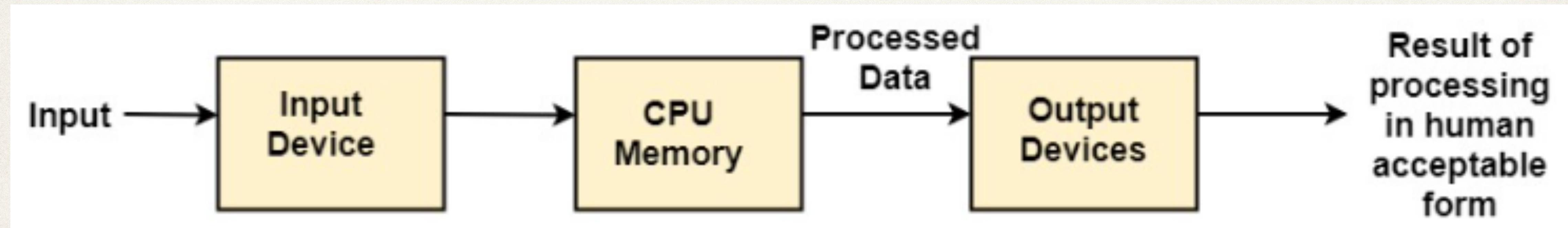
❖ **Disadvantages:**

- We cannot transfer the color values from one to another device.
- Complex to determine the particular color.

# Input Devices

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



# These Devices include:

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- ❖ Keyboard
- ❖ Mouse
- ❖ Trackball
- ❖ Spaceball
- ❖ Joystick
- ❖ Light Pen
- ❖ Digitizer
- ❖ Touch Panels
- ❖ Voice Recognition
- ❖ Image Scanner

# Keyboard :

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- ❖ The most commonly used input device is a keyboard. The data is entered by pressing the set of keys. All keys are labeled. A keyboard with 101 keys is called a QWERTY keyboard.
- ❖ The keyboard has alphabetic as well as numeric keys. Some special keys are also available

- ✿ **Numeric Keys:** 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- ✿ **Alphabetic keys:** a to z (lower case), A to Z (upper case)
- ✿ **Special Control keys:** Ctrl, Shift, Alt
- ✿ **Special Symbol Keys:** ; , " ? @ ~ ? :
- ✿ **Cursor Control Keys:** ↑ → ← ↓
- ✿ **Function Keys:** F1 F2 F3....F9.
- ✿ **Numeric Keyboard:** It is on the right-hand side of the keyboard and used for fast entry of numeric data.

# Function of keyboard :

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1. Alphanumeric Keyboards are used in CAD. (Computer Aided Drafting)
2. Keyboards are available with special features like screen co-ordinates entry, Menu selection or graphics functions, etc.
3. Special purpose keyboards are available having buttons, dials, and switches. Dials are used to enter scalar values. Dials also enter real numbers. Buttons and switches are used to enter predefined function values.

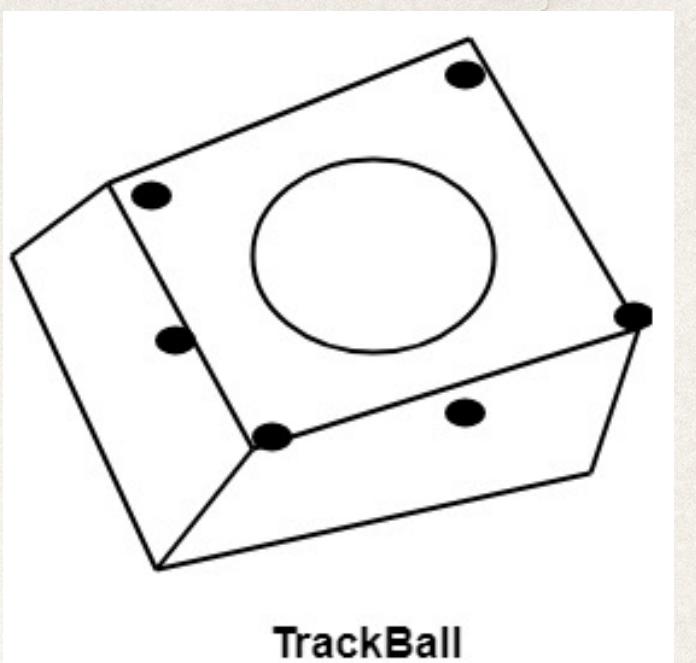
**\* Advantage:**

- Suitable for entering numeric data.
- Function keys are a fast and effective method of using commands, with fewer errors.

**\* Disadvantage:**

- Keyboard is not suitable for graphics input

# Trackball



- ❖ It is a pointing device. It is similar to a mouse. This is mainly used in notebook or laptop computer, instead of a mouse.
- ❖ This is a ball which is half inserted, and by changing fingers on the ball, the pointer can be moved.
- ❖ **Advantage:**
  - Trackball is stationary, so it does not require much space to use it.
  - Compact Size

# Joystick



- ❖ A Joystick is also a pointing device which is used to change cursor position on a monitor screen.
- ❖ Joystick is a stick having a spherical ball as its both lower and upper ends as shown in fig. The lower spherical ball moves in a socket. The joystick can be changed in all four directions.
- ❖ The function of a joystick is similar to that of the mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

# Light Pen

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- ✿ Light Pen (similar to the pen) is a pointing device which is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube. When its tip is moved over the monitor screen, and pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signals to the CPU.



## Uses :

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1. Light Pens can be used as input coordinate positions by providing necessary arrangements.
2. If background color or intensity, a light pen can be used as a locator.
3. It is used as a standard pick device with many graphics system.
4. It can be used as stroke input devices.
5. It can be used as evaluators

# Digitizers



- ❖ The digitizer is an operator input device, which contains a large, smooth board (the appearance is similar to the mechanical drawing board) & an electronic tracking device, which can be changed over the surface to follow existing lines.
- ❖ The electronic tracking device contains a switch for the user to record the desire x & y coordinate positions.
- ❖ The coordinates can be entered into the computer memory or stored or an off-line storage medium such as magnetic tape.

❖ **Advantages:**

- Drawing can easily be changed.
- It provides the capability of interactive graphics.

❖ **Disadvantages:**

- Costly
- Suitable only for applications which required high-resolution graphics.

# Image Scanner

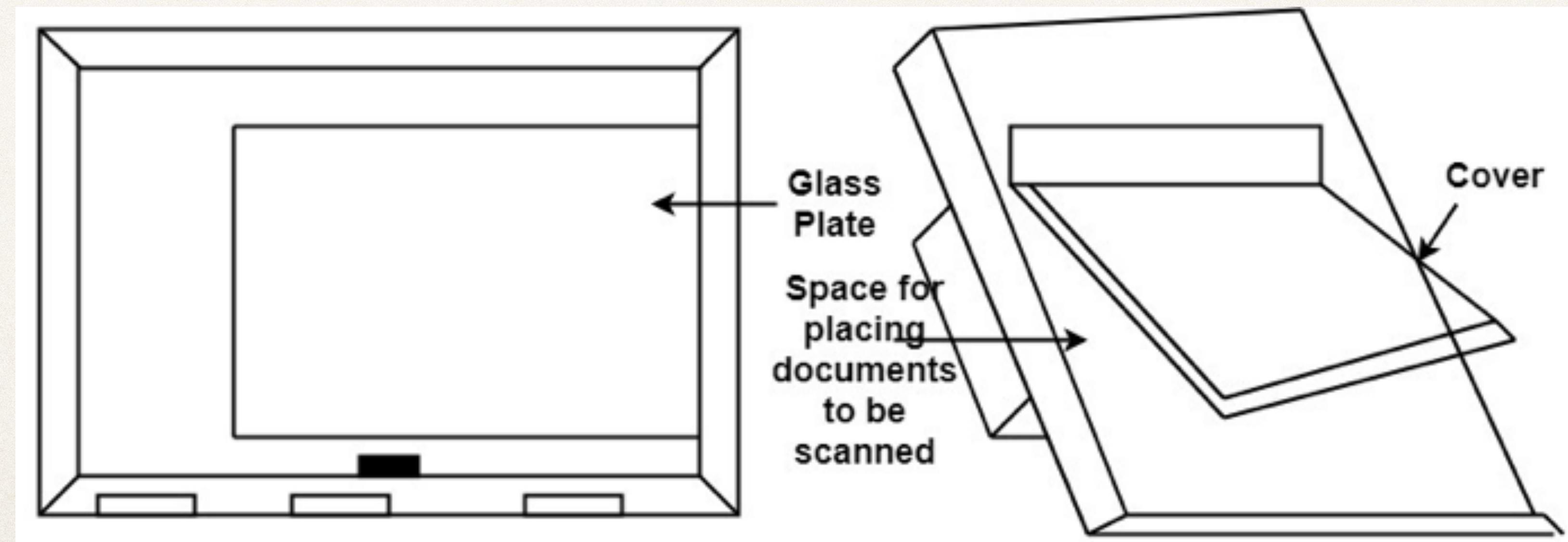
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- ❖ It is an input device. The data or text is written on paper. The paper is feeded to scanner. The paper written information is converted into electronic format; this format is stored in the computer. The input documents can contain text, handwritten material, picture extra.
- ❖ By storing the document in a computer document became safe for longer period of time. The document will be permanently stored for the future. We can change the document when we need. The document can be printed when needed.
- ❖ Scanning can be of the black and white or colored picture. On stored picture 2D or 3D rotations, scaling and other operations can be applied.

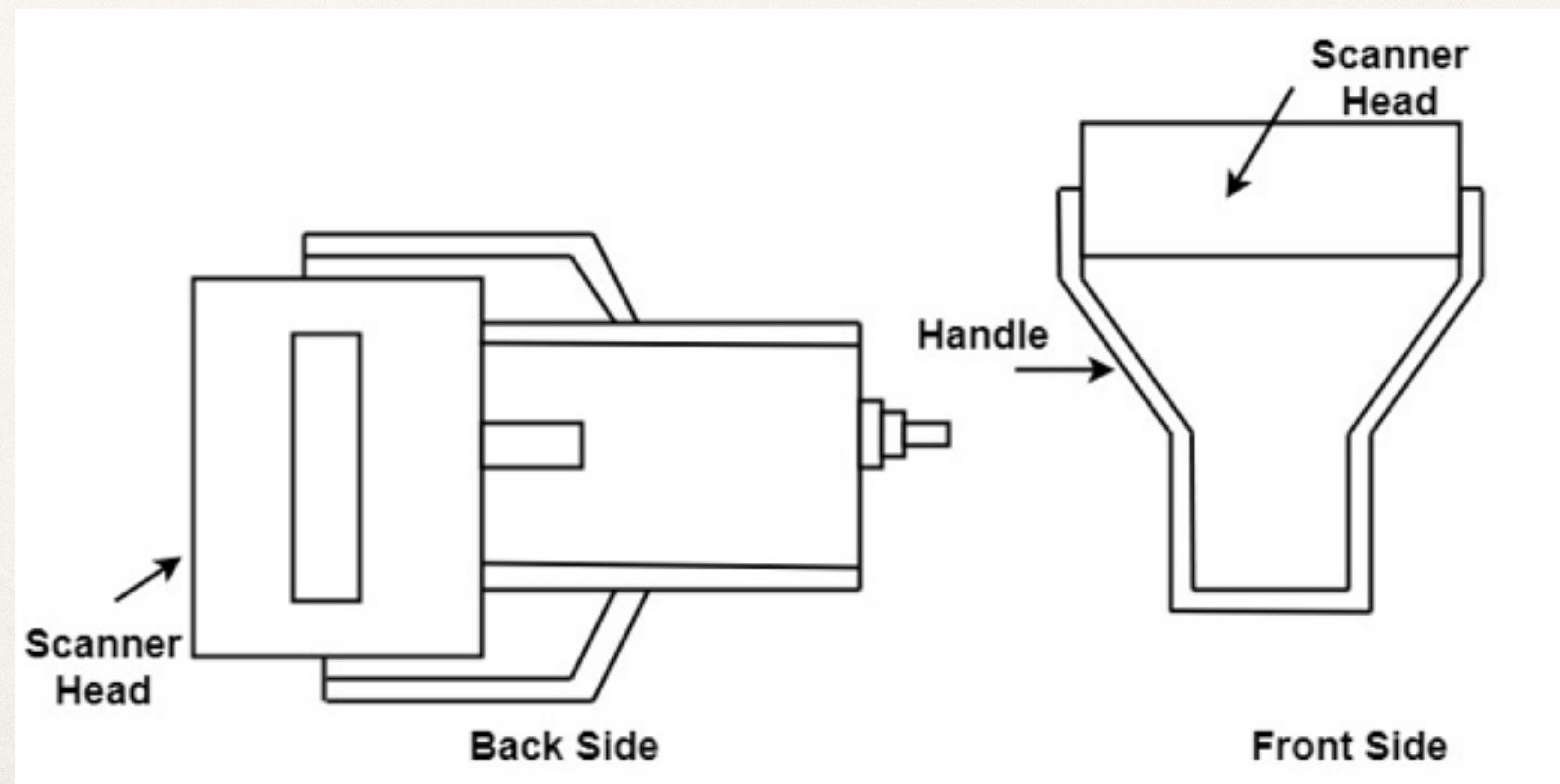
# Types of image scanner :

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- **Flat Bed Scanner:** It resembles a photocopy machine. It has a glass top on its top. Glass top is further covered using a lid. The document to be scanned is kept on glass plate. The light is passed underneath side of glass plate. The light is moved left to right. The scanning is done line by line. The process is repeated until the complete line is scanned. Within 20-25 seconds a document of 4" \* 6" can be scanned.



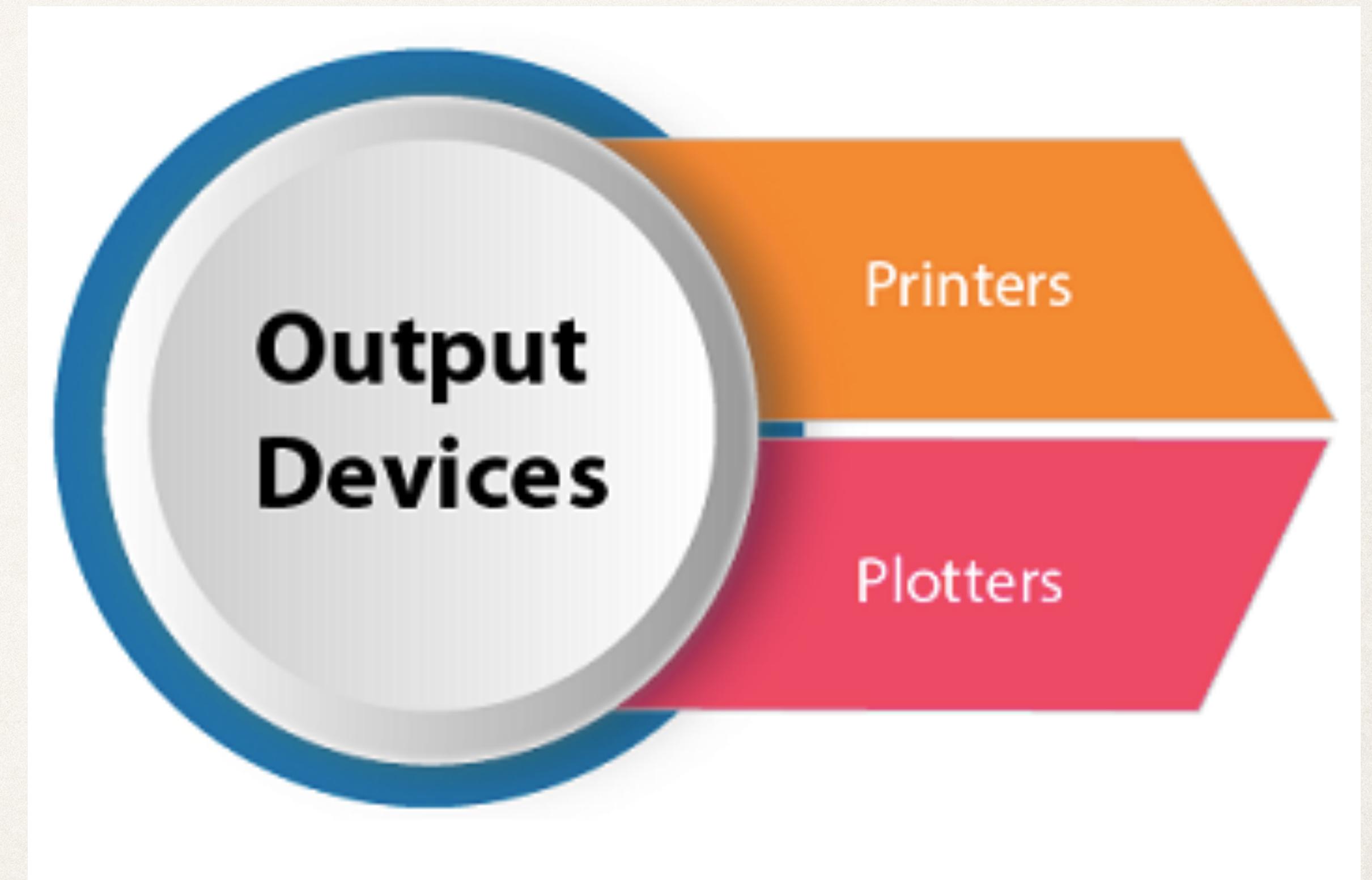
- ✿ **Hand Held Scanner:** It has a number of LED's (Light Emitting Diodes) the LED's are arranged in the small case. It is called a Hand held Scanner because it can be kept in hand which performs scanning. For scanning the scanner is moved over document from the top towards the bottom. Its light is on, while we move it on document. It is dragged very slowly over document. If dragging of the scanner over the document is not proper, the conversion will not correct.



# Output Devices

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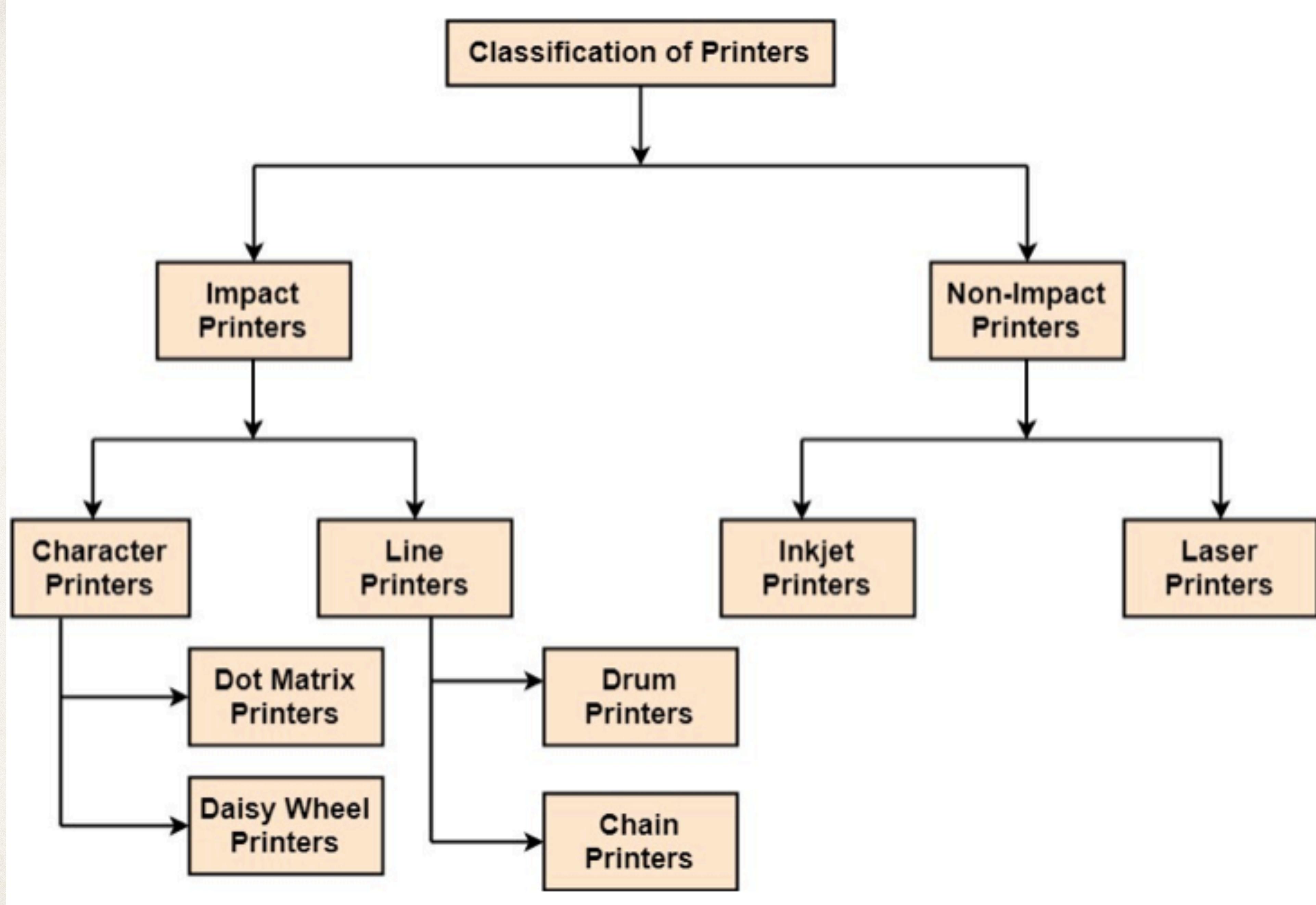
- ❖ It is an electromechanical device, which accepts data from a computer and translates them into form understand by users.



# Printers

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- ❖ Printer is the most important output device, which is used to print data on paper.
- ❖ **Types of Printers:** There are many types of printers which are classified on various criteria as shown in fig:



# Plotters

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- ❖ Plotters are a special type of output device. It is suitable for applications:
  1. Architectural plan of the building.
  2. CAD applications like the design of mechanical components of aircraft.
  3. Many engineering applications.



❖ **Advantages:**

1. It can produce high-quality output on large sheets.
2. It is used to provide the high precision drawing.
3. It can produce graphics of various sizes.
4. The speed of producing output is high.

# Graphic Softwares :

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- ✿ *General Purpose Packages*: Basic Functions in a general package include those for generating picture components (straight lines, polygons, circles and other figures), setting color and intensity values, selecting views, and applying transformations.
- ✿ Example of general purpose package is the GL (Graphics Library), GKS, PHIGS, PHIGS+ etc.

- ❖ *Special Purpose Packages:* These packages are designed for non programmers, so that these users can use the graphics packages, without knowing the inner details.
- ❖ Example of special purpose package is
  1. Painting programs
  2. Package used for business purpose
  3. Package used for medical systems.
  4. CAD packages