6.4 Introduction of computer graphics

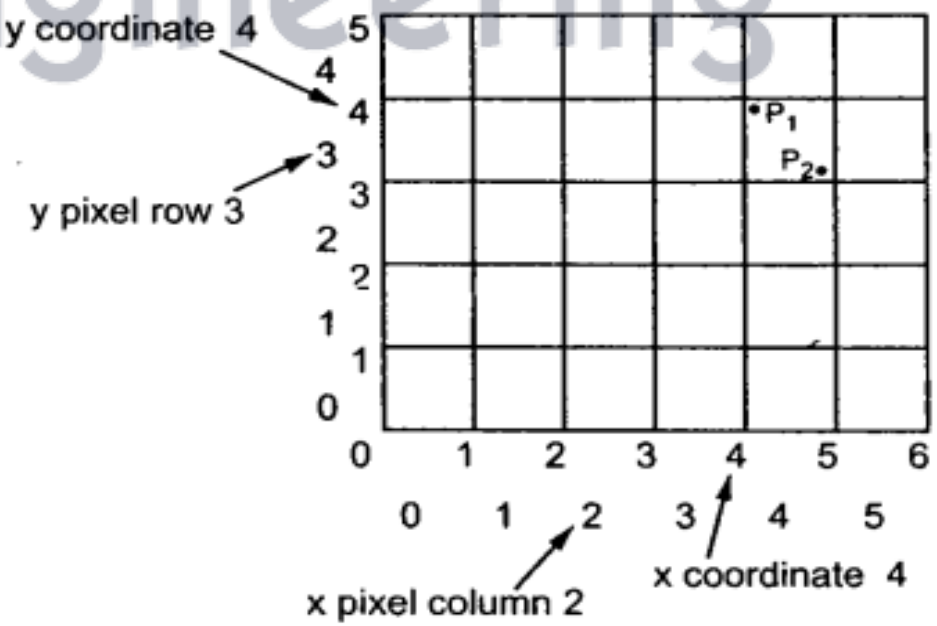
- Overview of Computer Graphics,
- Graphics Hardware (Display Technology, Architecture of Raster-Scan Displays, Vector Displays, Display Processors, output device and Input Devices),
- Graphics Software and Software standards.

Computer Graphics

- A computer is a machine that processes information. It stores, changes, and connects data.
- There are many ways to show this information to people. Computer graphics is a very common and effective way to show processed information.
- Instead of just words, it uses pictures, charts, graphs, and diagrams.
- Computer graphics changes data into pictures.
- These pictures can be engineering drawings, business graphs, or parts of a machine.
- In computer graphics, pictures are made of tiny dots called pixels.
- Pixels are the smallest parts of a screen we can control.
- We control pixels by changing their brightness and color.

Computer Graphics

- Each pixel on the graphics display does not represent mathematical point. Rather, it represents a region which theoretically can contain an infinite number of points. For example, if we want to display point Pl (4.2, 3.8) and point P2 (4.8, 3.1) then P1 and P2 are represented by only one pixel (4, 3), as shown in the figure below. In general, a point is represented by the integer part of x and integer part of y, i.e., pixel (int (x), int (y)).



Computer Graphics

- The process of determining the approximate pixels for representing a picture or graphics objects is known as **rasterization**.
- The process of representing continuous pictures or graphics objects as a collection of discrete pixels is called **scan conversion**.

Advantages of Computer Graphics

- Increases Usability
- Product Development and Research
- Employment Opportunities
- Designing
- Teaching Learning activities becomes easy

Disadvantages of Computer Graphics

- **Complexity**
- **Expensive**
- **Limitations**
- **Cost Ineffective**
- **Increase heat and weight of the system**

Applications of Computer Graphics

- **Computer Aided Design/Drafting (CAD and CADD):**
- **Presentation graphics**
- **Entertainment**
- **Computer Aided learning (CAL)**
- **Computer Art**
- **Graphical User Interface (GUI)**
- **Internet**
- **Education**
- **Geographical information system (GIS)**
- **Training**

Input Devices

1. Keyboard:

- The most commonly used input device is a keyboard. The data is entered by pressing the set of keys. All keys are labelled.
- 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...
- Numeric Keyboard: It is on the right-hand side of the keyboard and used for fast entry of numeric

Input Devices

2. Mouse:

- A Mouse is a pointing device and used to position the pointer on the screen.
- It is a small palm size box.
- The movement of the mouse along the x-axis helps in the horizontal movement of the cursor and the movement along the y-axis helps in the vertical movement of the cursor on the screen.
- The mouse cannot be used to enter text. Therefore, they are used in conjunction with a keyboard.

Input Devices

3. 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.

Input Devices

4. Joystick:

- A Joystick is also a pointing device which is used to change cursor position on a monitor screen.
- 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.

Input Devices

5. Voice Systems (Voice Recognition):

- Voice Recognition is one of the newest, most complex input techniques used to interact with the computer. The user inputs data by speaking into a microphone. The simplest form of voice recognition is a one-word command spoken by one. Each command is isolated with pauses between the words.
- Voice Recognition is used in some graphics workstations as input devices to accept voice commands. The voice-system input can be used to initiate graphics operations or to enter data. These systems operate by matching an input against a predefined dictionary of words and phrases.

Input Devices

6. Scanner:

- Used to scan photos or documents into a computer. You can then use these pictures in digital graphics software.

7. CD Rom:

- Used in reading discs. You put the disc in the CD rom drive and it reads it, and whatever is on there, whether it be photos or a program it will open or install.

Output Devices

1. Printers:

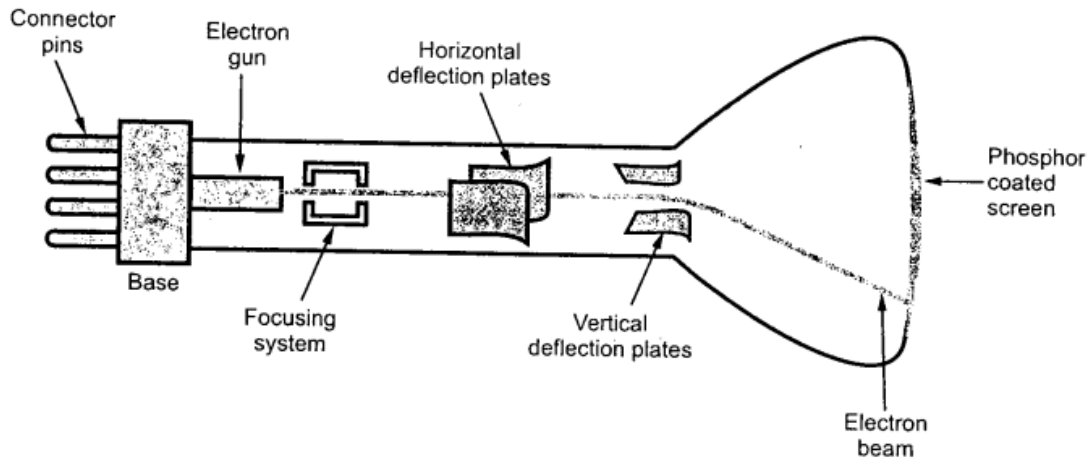
- A printer is a peripheral device which is used to represent the graphics or text on paper. The quality is measured by its resolution. The resolution of any printer is measured in dot per inch (dpi).
- The printer usually works with the computer and connected via a cable. In present, many digital device support printer features so that we can use Bluetooth, Wi-fi, and cloud technology to print.

Output Devices

2. Video Display Devices:

- The most commonly used output device in a graphics system is video monitor. The operation of most video monitors is based on standard Cathode Ray tube (CRT) design.

Output Devices

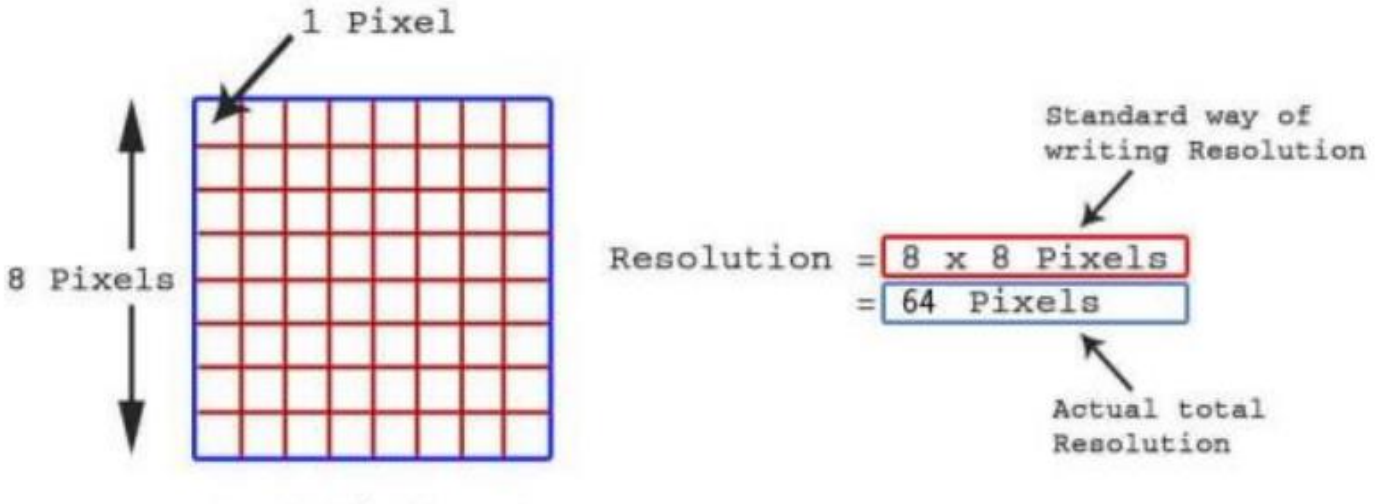


Cathode Ray Tube:

- CRT is a display screen which produces images in the form of the video signal.
- It is a type of vacuum tube which displays images when the electron beam through electron guns are strikes on the phosphorescent surface.
- In other Words, the CRT generates the beams, accelerates it at high velocity and deflect it for creating the images on the phosphorous screen so that the beam becomes visible.
- A Cathode-ray Tube is used as computer monitors, television screens or radar displays.

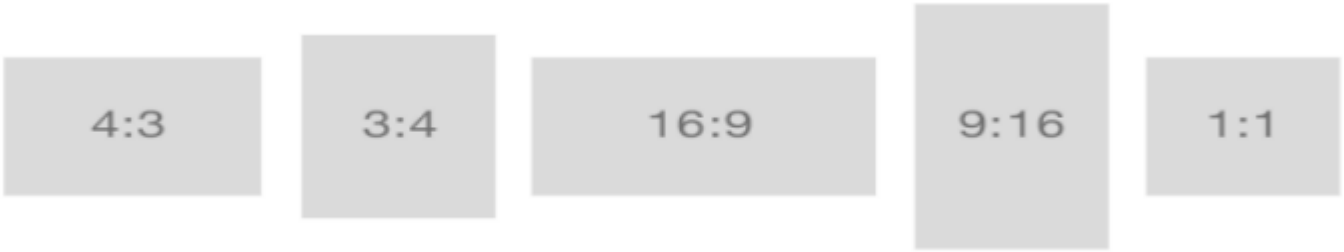
Resolution

- Resolution measures how much detail an image can have.It determines how clear and sharp the image appears.
- Higher resolution images have more pixels, which results in finer details and smoother edges.
- Resolution is defined as the maximum member of points that can be displayed horizontally and vertically without overlap on a display device.



Aspect Ratio

- Aspect Ratio gives that ratio of horizontal point to vertical points necessary to produce equal length lines in both directions on the screen an aspect ratio of 3/4 means that a vertical line plotted with 3 points has the same length as a horizontal line plotted with 4 points.
- Aspect ratio = Width / Height
- In, for example, a group of images that all have an aspect ratio of 16:9, one image might be 16 inches wide and 9 inches high, another 16 centimeters wide and 9 centimeters high, and a third might be 8 yards wide and 4.5 yards high.



Refresh rate

- The refresh rate is the number of times per second the image is redrawn to give a feeling of un-flickering pictures and it is usually 50 per second.
- As the refresh rate decreases flicker develops because the eye can no longer integrate the individual light impulses coming from a pixel.

Horizontal scan rate

Horizontal scan rate:

- The horizontal scan rate is the number of scan lines per second.
- The rate is approximately the product of the refresh rate and the number of scan lines.

Resolution

Resolution:

- Resolution is defined as the maximum number of points that can be displayed horizontally and vertically without overlap on a display device.

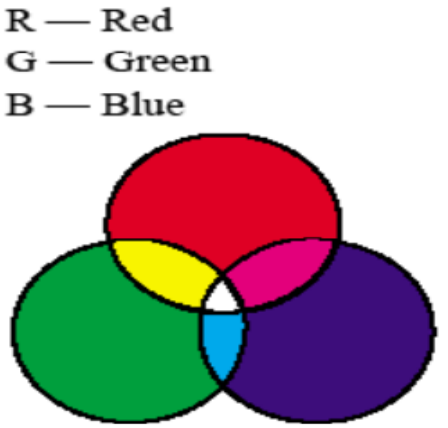
Color Systems

- Color is what we see when light interacts with things around us.
- It is the way we perceive the different wavelengths of light.
- The human eye can see about 1 million different colors, which are created by mixing different wavelengths of light.
- For example, when white light hits an object, some of the wavelengths are absorbed by the object and some are reflected. The reflected wavelengths are what we see as the object's color. So, a red apple reflects red light and absorbs all other wavelengths.

Colour System

- Colour is a vital component of multimedia. Colour management is both subjective and technical exercise, because:
  - Colour is a physical property of light but
  - Colour perception is a human physiological activity
  - Choosing a right colour or colour combination involves many trials and aesthetic judgement
  - Colour is a physical property of light, and it is determined by the wavelength of the light wave. The human eye can see light waves in the range of 380 to 760 nanometers, which is why we can see the colors that we do.

RGB Colour Model



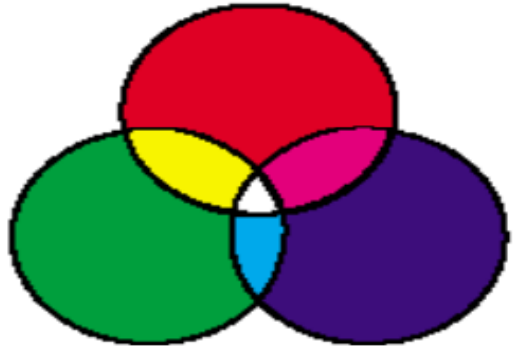
- RGB stands for Red, Green, Blue.
- It is probably the most popular colour model used in computer graphics.
- It is an additive system in which varying amount of three colours red, green and blue are added to produce new colours.
- All other colors can be created by mixing these three primary colors in different ways.
- The amount of each primary color is represented by a value between 0 and 255, where 0 is the absence of the color and 255 is the full intensity of the color.

RGB Colour Model

- For example, the color red is represented by the value (255, 0, 0), which means that the red component is at full intensity and the green and blue components are at zero intensity.
- The RGB color model is used in many digital devices, such as computer monitors, televisions, and cameras.

RGB Colour Model

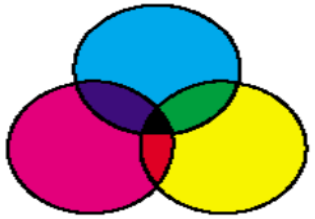
R — Red
G — Green
B — Blue



- RGB color model can be used to create different colors:
  - Mixture of red and green light creates yellow light.
  - Mixture of red and blue light creates magenta light.
  - Mixture of green and blue light creates cyan light.
  - Mixture of all three primary colors (red, green, and blue) creates white light.
  - No light at all creates black.

C — Cyan
M — Magenta
Y — Yellow

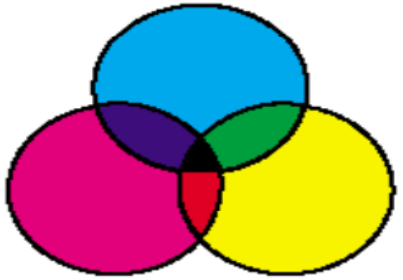
CMY Color Model



- The three primary colors in the CMY model are cyan, magenta, and yellow.
- Cyan, Magenta and Yellow should absorb all the light thus resulting in black.
- It is a subtractive color model, which means that colors are created by subtracting different wavelengths of light.
- The amount of each primary color is represented by a value between 0 and 1, where 0 is the absence of the color and 1 is the full intensity of the color.
- For example, the color red is represented by the value (0, 0, 1), which means that the cyan and magenta components are at zero intensity and the yellow component is at full intensity.
- It is used in printing, where it is used to create inks that can be used to reproduce colors on paper.

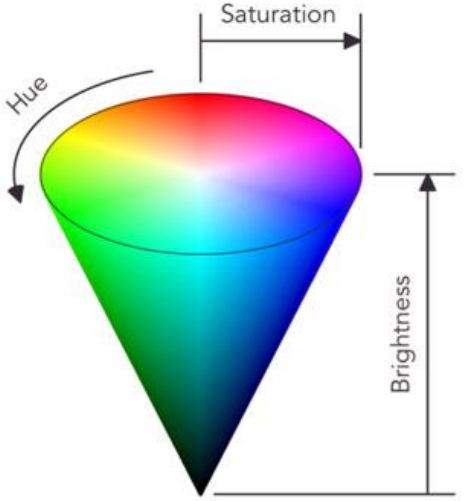
CMY Color Model

C — Cyan
M — Magenta
Y — Yellow



- How the CMYK color model can be used to create different colors:
  - Mixture of cyan and yellow light creates green light.
  - Mixture of magenta and yellow light creates red light.
  - Mixture of cyan, magenta, and yellow light creates black.
  - Adding black to any of the colors will make the color darker.
- The CMYK color model is not as widely used in digital devices as the RGB color model, because it is not as accurate.

HSB Colour Model



- HSB color model is a way of representing colors by their hue, saturation, and brightness.
- It's a way to represent colors in a more intuitive and human-friendly manner.
- **Hue** is identified by the name of the colour. It is measured as a location on the standard colour wheel as a degree between 0 degree to 360 degree.
- **Saturation** is the strength or purity of the color. It represents the amount of gray proportion to the hue and is measured as a percentage from 0% (gray) to 100% (fully saturated).
- **Brightness** is the relative lightness or brightness of colour. It is measured as a percentage from 0% (black) to 100% (white).

YUV Colour Model

- YUV color model is a color space that represents colors using three components: luma (Y), blue difference (U), and red difference (V).
- Luma (Y) is the brightness or lightness of the color. Higher Y values indicate brighter areas, and lower values indicate darker areas.
- Blue difference (U) is the difference between the blue and luma components. Positive U values indicate more blue, negative values indicate less blue.
- Red difference (V) is the difference between the red and luma components. Positive V values indicate more red, negative values indicate less red.

YUV Model

- YUV colors:
  - Black = 0, 0, 0
  - White = 255, 255, 255
  - Red = 255, 0, 0
  - Green = 0, 255, 0
  - Blue = 0, 0, 255
  - Yellow = 255, 255, 0
  - Magenta = 255, 0, 255
  - Cyan = 0, 255, 255
- A Y value of 255 indicates maximum brightness. A U value of 255 means that there is a maximum amount of blue color information relative to the brightness. A V value of 255 indicates a maximum amount of red color information relative to the brightness.

Raster Vs Random Scan System

Raster scan system	Random scan system
• The electron beam is swept across the screen, one row at a time, from top to bottom	• The electron beam is directed only to the parts of screen where a picture is to be drawn.
• Its resolution is poor because raster systems in contrast produces zigzag lines that are plotted as discrete point sets.	• Its resolution is good because this system produces smooth lines drawings because CRT beam directly follows the line path.
• Picture definition is stored as a set of intensity values for all screen points, called pixels in a refresh buffer area.	• Picture definition is stored as a set of line drawing instructions in a display file.
• The capability of this system to store intensity values for pixel makes it well suited for the realistic display of scenes contain shadow and color pattern.	• These systems are designed for line-drawing and can't display realistic shaded scenes.
• Screen points/ pixels are used to draw an image	• Mathematical function are used to draw an image.
• It is used for photos. That is why Photoshop is a raster editing program	• It is used for text, logos, and letter heads.
• It is less expensive	• It is costlier than raster scan system
• It occupy more space which depends upon image quality and file extension may be .BMP, .TIF .JPG.	• It occupy less space and file extension may be .PDF, .AI

Numericals

- Consider raster systems with the resolutions of 640 x 480.

a) What size is frame buffer (in bytes) for this systems to store 12 bits per pixel?

→ Eight bits constitute a byte, and frame-buffer sizes of the system is as follows: 640 x 480 x 12 bits / 8 = 460800 Byte = 450KB (1024 Byte = 1 KB)

Numericals

- b) How many pixels could be accessed per second in this system by a display controller that refreshes the screen at a rate of 60 frames per second?

→Since 60 frames are refreshed per second and each frame consists of 640 x 480 pixels, the access rate of such a system is:

→ (640 x 480) * 60 = 1.8432 x 107 pixels/second

Numericals

- Find out the aspect ratio of the raster system using 8 x 10 inches screen and 100 pixel/inch.

→We know that, Aspect ratio = Width / Height

= 8 x 100 / 10 x 100

= 4 / 5

Aspect ratio = 4: 5

Numericals

- How long would it takes to load a 640 X 480 frame buffer with 12 bit per pixels if 10^5 bits can be transferred per second?

→Total size of frame buffer = 640 X 480 X 12

→It takes = (640 X 480 X 12) / 10^5

Graphics Software

- In computer graphics, graphics software refers to a program or collection of programs that enable a person to manipulate images or models visually on a computer. Computer graphics can be classified into distinct categories: raster graphics and vector graphics, with further 2D and 3d variants.
- Many graphics programs focus exclusively on either vector or raster graphics, but there are a few that combine them in interesting ways. It is simple to convert from vector graphics to raster graphics, but going the other way is harder. Some software attempts to do this

Graphics Software

- In addition to static graphics, there are animation and video editing software. Different types of software are often designed to edit different types of graphics such as video, photos, and drawings. The exact sources of graphics may vary for different tasks, but most can read and write files.
- Most graphics programs have the ability to import and export one or more graphics file formats, including those formats written for a particular computer graphics program. Examples of such programs include Vectr, GIMP, Adobe Photoshop, Pizap, Microsoft Publisher, Picasa, etc.

Graphics Software

- Interactive graphics allow users to make change over the displayed objects. Several graphics software packages are now available. There are two general classifications for graphics software:
  - General programming packages
  - Special-purpose application packages

General programming packages

- contain graphics functions that can be used with high level programming languages such as C, FORTRAN, Java etc. Example, Open GL (Graphics library).
- A general-purpose graphics package provides users with a variety of functions for creating and manipulating pictures.
- These graphic functions include tools for generating picture components, setting color, selecting views, and applying transformations.

Special-purpose application packages

- Specifically designed for particular applications. Maya, CINEMA 4D are particularly used for animations, different types of CAD applications are designed for medical and business purposes.
- These are primarily oriented to non-programmers.