COMPUTER GRAPHICS

SEMESTER 5
UNIT - 1

HI COLLEGE

SYLLABUS

UNIT - 1

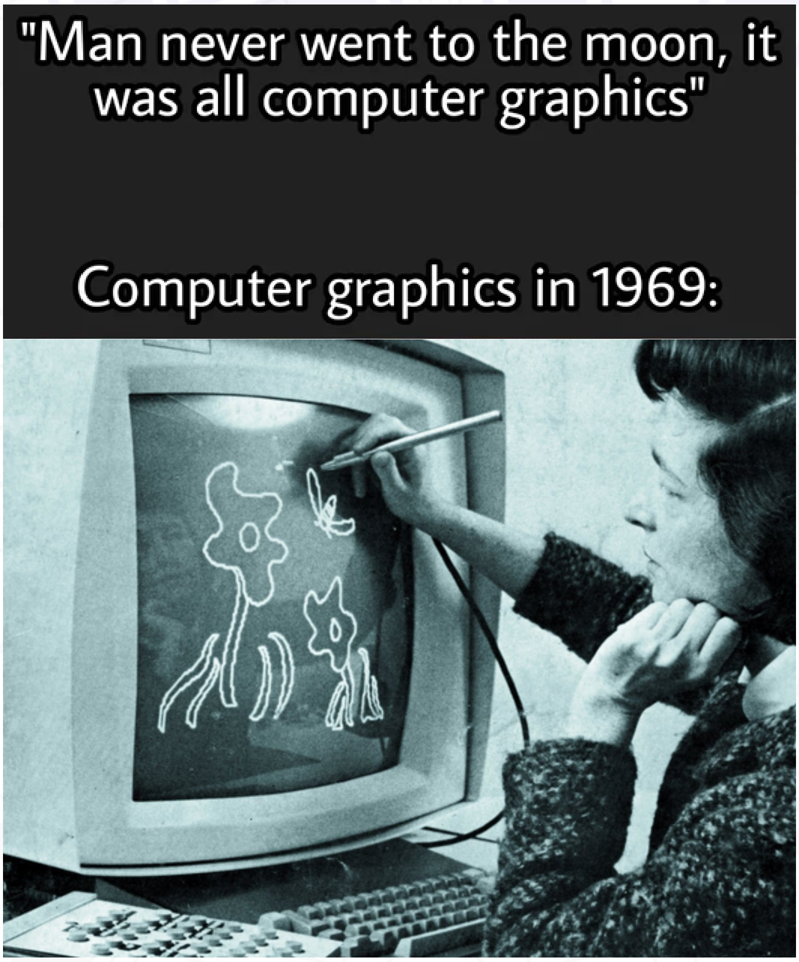
UNIT – I

No. of Hours: 11 **Chapter/Book Reference: TB1, TB2**

Introduction: Introduction to computer graphics, Applications of Computer Graphics, Non Interactive and interactive graphics, Conceptual Framework for Interactive Graphics. Introduction to Raster and Random scan display, Characteristics of display devices, Aliasing and Antialiasing, Introduction to latest display technologies (LED, OLED, Curved LED display)

Scan Conversion

Scan Converting Lines using DDA & Bresenham's Algorithm, Scan Converting Circles using Bresenham's algorithm.



INTRODUCTION TO COMPUTER GRAPHICS,

INTRODUCTION

Computer graphics is the use of computers to create and manipulate visual images. It is a vast field that encompasses many different techniques, including 2D graphics, 3D graphics: Animation, Rendering, Image processing.

APPLICATIONS OF COMPUTER GRAPHICS

- **Entertainment**: Computer graphics are used to create special effects and realistic images in movies, video games, and television shows.
- **Science and engineering:** Computer graphics is used to visualise and analyse data, and to create simulations of physical systems.
- **Design**: Computer graphics is used to create and prototype products, and to design buildings and other structures.
- **Education**: Computer graphics is used to create educational materials, such as diagrams and animations.
- **Medicine**: Computer graphics are used to create medical images, such as X-rays and MRI scans, and to develop surgical simulations.
- **Business**: Computer graphics are used to create presentations, charts, and other visual aids.
- **Manufacturing**: Computer graphics is used to create computer-aided design (CAD) models and to control manufacturing processes.

NON INTERACTIVE AND INTERACTIVE GRAPHICS,

INTERACTIVE GRAPHICS	NON-INTERACTIVE GRAPHICS
• Also known as active graphics	• Also known as passive graphics
• User have some sort of control over the graphics	• Users have no control over the image/graphics.
• Dynamic control nature	• Static control nature
• Two way communication b/w user and computer	• one way communication b/w user and computer
• Higher bandwidth interaction with user	• No interaction with the user.
• For example: All modern day computer graphics.	• For example: Television, art illustration etc.

CONCEPTUAL FRAMEWORK FOR INTERACTIVE GRAPHICS

1. **Human-Computer Interaction (HCI):** This is the study of how people interact with computers and other digital devices. HCI principles are used to design interfaces that are easy to use, efficient, and effective. For interactive graphics, HCI is particularly important because it concerns the user's experience with the graphical user interface (GUI) and how it interacts with the user's cognitive processes.
2. **Interaction Techniques:** These are the methods used to manipulate objects in the graphical interface. They may include pointing, dragging, rotating, scaling, and other actions. A good interaction technique is one that facilitates easy and intuitive manipulation of objects, without causing errors or confusion.
3. **Input Devices:** These are the hardware devices that allow users to provide input to graphical applications. They may include a keyboard, mouse, touch screen, stylus, or other devices. Input devices play a significant role in the usability of interactive graphics, as they provide the means by which users can manipulate objects in the scene.

4. Rendering Techniques: These are the methods used to display digital content on a screen or other output device. They may include techniques such as rasterization, ray tracing, and real-time rendering. The choice of rendering technique depends on the application's requirements, the hardware capabilities, and the desired visual quality.

5. Algorithms: These are the mathematical calculations that support interactive graphics. They may include algorithms for 3D modeling, animation, physics simulation, and image processing. The choice of algorithm depends on the specific application's requirements.

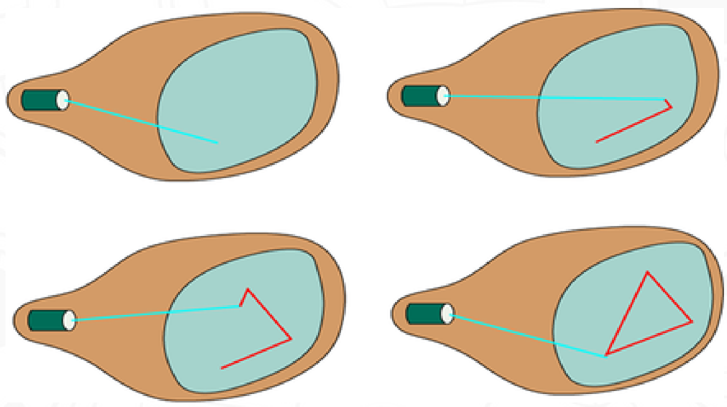
INTRODUCTION TO RASTER AND RANDOM SCAN DISPLAY

Raster display uses a grid of pixels, with each pixel representing a small area on the screen that can be individually controlled to generate the image. Raster displays are commonly used in modern computer monitors, televisions, and other digital displays. Each pixel on the screen is assigned a color value, which is stored in a memory location and displayed on the screen. Raster displays are characterized by their high resolution, fast refresh rates, and low cost.

Random scan display, on the other hand, uses a beam of electrons to generate the image on the screen. This beam is directed over the screen by a magnetic field and is used to illuminate phosphors on the display. The phosphors emit light in response to the electron beam, creating the image on the screen. Random scan displays are also known as vector displays and are commonly used in older computer systems and specialized graphics applications.

One **advantage** of random scan displays is that they can draw lines and shapes more quickly than raster displays. This is because the electron beam can move more quickly than the method used to update the pixels on a raster display. However, random scan displays generally have lower resolution and can only display a limited number of colors.

Random Scan Display



CHARACTERISTICS OF DISPLAY DEVICES,

1. Resolution: Resolution refers to the number of pixels (or dots) that can be displayed on the screen. Higher resolutions provide more detail and greater visual clarity, but also require more processing power and higher bandwidth to display.

2. Contrast: Contrast refers to the difference between the lightest and darkest areas of the screen. Displays with higher contrast ratios provide sharper and more detailed images.

3. Refresh rate: Refresh rate refers to how quickly the display can update the screen images. Higher refresh rates help to prevent flickering and improve the fluidity of motion on the screen.

4. Viewing angle: The viewing angle refers to the angle at which the user can view the screen without significant degradation of image quality. Displays with wider viewing angles can be viewed from more angles without distortion.

5. Color reproduction: The ability of display devices to accurately reproduce colors varies widely. Higher-end systems with advanced color management systems can provide more accurate and consistent color reproduction.

6. Size and aspect ratio: The size and aspect ratio of the display device can affect how content is presented and perceived. Wider aspect ratios are better suited for video content, while taller aspect ratios can be better for text-based content.

7. Brightness and luminance: The brightness and luminance of a display determine how much light the screen emits, which affects how easy it is to view in a variety of lighting conditions.

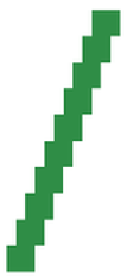
ALIASING AND ANTIALIASING,

Aliasing and Antialiasing are two concepts related to the representation of images on a digital display.

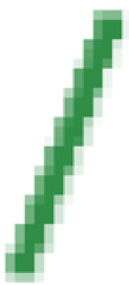
Aliasing occurs when an image is displayed with jagged or pixelated edges, resulting in a staircase-like appearance. This is caused by the low sampling rate of the digital display, which cannot display a smooth curve or line. Aliasing is more noticeable in images with high contrast edges or fine details. It can be reduced by increasing the display resolution, which allows for more precise rendering of the edges.

Antialiasing is a method for reducing aliasing in digital images by smoothing out jagged edges and minimizing pixelation. This is done by applying smoothing techniques, such as blurring or averaging, to the edges of the image, which reduces the contrast between neighboring pixels and creates a smoother transition between colors. Antialiasing can be applied at different stages of the image processing pipeline - at the level of graphics hardware, image processing software, or display technology.

Antialiasing techniques can be classified into two types: spatial and temporal. Spatial antialiasing is applied by altering the spatial position of the pixels, reducing the resolution, or increasing the sampling rate. Temporal antialiasing is applied by analyzing several frames of the image and using a motion estimation process to reduce the temporal variance of the images, which can cause aliasing artifacts.



Without Antialiasing



With Antialiasing

INTRODUCTION TO LATEST DISPLAY TECHNOLOGIES

1. LED displays: LED stands for Light Emitting Diode. An LED display is made up of multiple LEDs, which emit light when an electric current is passed through them. LED displays are commonly used in large outdoor displays, billboards, and stadium screens. They are known for their brightness, sharpness, and durability. LED displays can be manufactured in various sizes, shapes, and resolutions.

2. OLED displays: OLED stands for Organic Light Emitting Diode. OLED displays are made up of organic materials, which emit light when an electric current is passed through them. OLED technology is used in modern phones, televisions, and monitors. OLED displays provide a higher contrast ratio, better color accuracy, and deeper blacks than LED displays. They are also thinner and more energy-efficient.

3. Curved LED displays: Curved LED displays are made up of curved LED panels, which are arranged in a curved shape to create a more immersive viewing experience. These displays are commonly used in theaters, museums, and other entertainment venues. The curved display panel helps to reduce reflections, improve viewing angles, and provide a more natural focal length for the human eye.

Overall, LED, OLED, and Curved LED displays are advanced technologies that have revolutionized the display industry. They provide higher brightness, contrast, color accuracy, and thus offer a more immersive viewing experience. These displays are increasingly popular for applications ranging from home entertainment to large-scale advertising.

SCAN CONVERSION

Scan conversion in computer graphics is the process of converting a geometric representation of an object, such as a line, curve, or polygon, into a pixel-based representation that can be displayed on a computer screen or printed on a page.

Imagine a picture that is drawn on a piece of paper. The picture is made up of continuous lines and curves. However, when we scan the picture into a computer, it is converted into a grid of pixels. Each pixel is a tiny square that has a specific colour. The scan converter determines the colour of each pixel based on the information in the original picture.

SCAN CONVERTING LINES USING DDA & BRESENHAM'S ALGORITHM

DDA ALGORITHM:

The DDA (Digital Differential Analyzer) algorithm is a simple yet effective scan conversion algorithm for lines. It works by calculating increments in x and y directions based on the slopes of the line. The algorithm then samples the line at equally spaced intervals and plots a pixel at each sample point. Below are the general steps of the DDA algorithm:

1. Calculate the slopes of the line: m = (y2 - y1) / (x2 - x1)
2. Determine the number of pixels to be drawn: N = max(|x2 - x1|, |y2 - y1|)
3. Calculate the incremental values of x and y: dx = (x2 - x1) / N and dy = (y2 - y1) / N
4. Starting from (x1,y1), for each i = 1,2,3 ...... N, calculate xi and yi using the following formulas:
 xi+1 = xi + dx
 yi+1 = yi + dy
5. Round off (xi, yi) to find the nearest pixel and plot the pixel at that point.

For example, suppose we want to draw a line from (2,3) to (7,9) using DDA algorithm.

First, we calculate the slope of the line: m = (9 - 3) / (7 - 2) = 1.2. Then we determine the number of pixels to be drawn: N = max(|7 - 2|, |9 - 3|) = 6.

We calculate the incremental values of x and y: dx = (7 - 2) / 6 = 1 and dy = (9 - 3) / 6 = 1.

We start from (2,3) and compute (3,4), (4,5), (5,6), (6,7), (7,8), (8,9) using the formulas xi+1 = xi + dx and yi+1 = yi + dy.

We round off each point to find its nearest pixel and plot the pixel at that point.

BRESENHAM'S ALGORITHM:

Bresenham's line algorithm is an efficient algorithm used for scan converting lines. It was developed by Jack E. Bresenham and uses only integer arithmetic to draw lines. The key idea behind Bresenham's algorithm is to avoid floating-point calculations in order to minimize computational overhead. Below are the general steps of the Bresenham's line algorithm:

1. Initialize x and y coordinates to the first endpoint of the line (x1, y1).
2. Calculate the differences between the x and y coordinates of the two endpoints: dx = x2 - x1 and dy = y2 - y1.
3. Initialize the decision variable, d, to (2 * dy - dx).
4. While x <= x2:
 A. Plot the pixel at (x,y).
 B. If d > 0, increment y by 1 and update d: d = d + (2 * dy - 2 * dx).
 C. Increment x by 1 and update d: d = d + 2 * dy.
5. Repeat step 4 until x = x2.

For example, suppose we want to draw a line from (2,3) to (7,9) using Bresenham's algorithm. We calculate the differences between the x and y coordinates of the two endpoints: dx = 7 - 2 = 5 and dy = 9 - 3 = 6. We initialize the decision variable, d, to (2 * dy - dx) = 9. We start from (2,3) and calculate d for each x-coordinate in the line as follows:

- x = 2, y = 3, d = 9, plot the pixel at (2,3)
- x = 3, y = 4, d = 13, plot the pixel at (3,4)
- x = 4, y = 5, d = 5, plot the pixel at (4,5)
- x = 5, y = 6, d = 9, plot the pixel at (5,6)
- x = 6, y = 7, d = 13, plot the pixel at (6,7)
- x = 7, y = 8, d = 5, plot the pixel at (7,8)
- x = 8, y = 9, d = 9, plot the pixel at (8,9)

By the end of this process, we have drawn a line from (2,3) to (7,9) using Bresenham's algorithm.

for better clarity **watch now**

SCAN CONVERTING CIRCLES USING BRESENHAM"S ALGORITHM.

Drawing a circle on the screen is a little complex than drawing a line. There are two popular algorithms for generating a circle – Bresenham's Algorithm and Midpoint Circle Algorithm.

The equation of circle is X2+Y2=r2,

where r is radius.

We cannot display a continuous arc on the raster display. Instead, we have to choose the nearest pixel position to complete the arc.

FOR EXAMPLE —

Draw a circle with center (50,50)and radius 20 by using bresenham algorithm

Let r = 10 (Given)

Step1: Take initial point (0, 10)

d = 3 - 2r

d = 3 - 2 * 10 = -17

d < 0 ∴ d = d + 4x + 6

= -17 + 4 (0) + 6

= -11

Step2: Plot (1, 10)

d = d + 4x + 6 (∵ d < 0)

= -11 + 4 (1) + 6

= -1

Step3: Plot (2, 10)

d = d + 4x + 6 (∵ d < 0)

= -1 + 4 x 2 + 6

= 13

Step4: Plot (3, 9) d is > 0 so x = x + 1, y = y - 1

d = d + 4 (x-y) + 10 (∵ d > 0)

= 13 + 4 (3-9) + 10

= 13 + 4 (-6) + 10

= 23-24=-1

Step5: Plot (4, 9)

d = -1 + 4x + 6

= -1 + 4 (4) + 6

= 21

Step6: Plot (5, 8)

d = d + 4 (x-y) + 10 (∵ d > 0)

= 21 + 4 (5-8) + 10

= 21-12 + 10 = 19

So P1 (0,0)⥤(50,50)

P2 (1,10)⥤(51,60)

P3 (2,10)⥤(52,60)

P4 (3,9)⥤(53,59)

P5 (4,9)⥤(54,59)

P6 (5,8)⥤(55,58)