COMPUTER GRAPHICS NOTES

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Course Objectives

1 To equip students with the fundamental knowledge and basic technical competence in the field of computer graphics.

2 To emphasize on implementation aspect of Computer Graphics Algorithms.

3 To prepare the student for advance areas like Image Processing or Computer Vision or Virtual Reality and professional avenues in the field of Computer Graphics.

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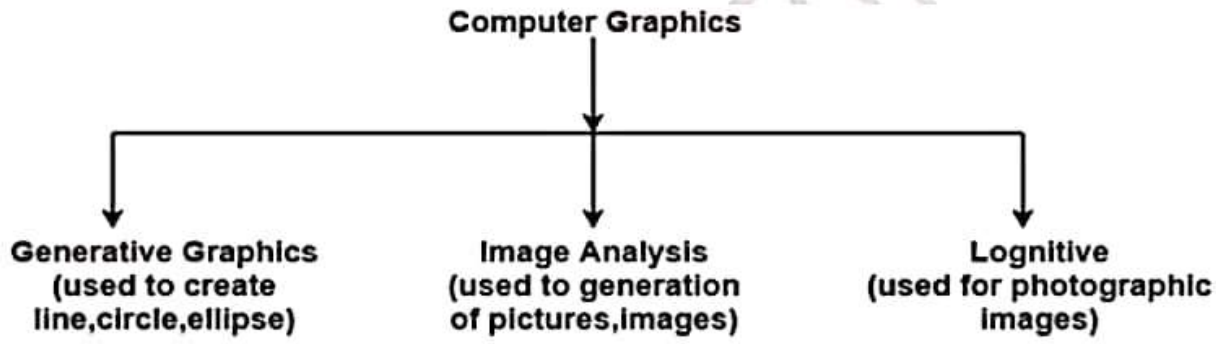
MODULE 01

Introduction to Computer Graphics

An art of drawing pictures on computer screen by using programming is known as Computer graphics. The activities involved in computer graphics are computations, creation and manipulation of data. The images are generated and manipulated by a rendering tool known as computer graphics.

It is the use of computers to create and manipulate pictures on a display device. It comprises of software techniques to create, store, modify, represents pictures.



Applications of computer graphics?

Computer Graphics has numerous applications, some of which are listed below −

- **Computer graphics user interfaces (GUIs)** − A graphic, mouse-oriented paradigm which allows the user to interact with a computer.
- **Business presentation graphics** − "A picture is worth a thousand words".
- **Cartography** − Drawing maps.
- **Weather Maps** − Real-time mapping, symbolic representations.
- **Satellite Imaging** − Geodesic images.
- **Photo Enhancement** − Sharpening blurred photos.
- **Medical imaging** − MRIs, CAT scans, etc. - Non-invasive internal examination.

- **Engineering drawings** – mechanical, electrical, civil, etc. - Replacing the blueprints of the past.
- **Typography** – The use of character images in publishing - replacing the hard type of the past.
- **Architecture** – Construction plans, exterior sketches - replacing the blueprints and hand drawings of the past.
- **Art** – Computers provide a new medium for artists.
- **Training** – Flight simulators, computer aided instruction, etc.
- **Entertainment** – Movies and games.
- **Simulation and modelling** – Replacing physical modelling and enactments

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Module 02

Scan Conversion

Definition:

It is a process of representing graphics objects a collection of pixels. The graphics objects are continuous. The pixels used are discrete. Each pixel can have either on or off state.

Any model of graphics can be reproduced with a dense matrix of dots or points. Most human beings think graphics objects as points, lines, circles, ellipses. For generating graphical object, many algorithms have been developed.

Advantage of developing algorithms for scan conversion

1. *Algorithms can generate graphics objects at a faster rate.*
2. *Using algorithms memory can be used efficiently.*
3. *Algorithms can develop a higher level of graphical objects.*

Examples of objects which can be scan converted

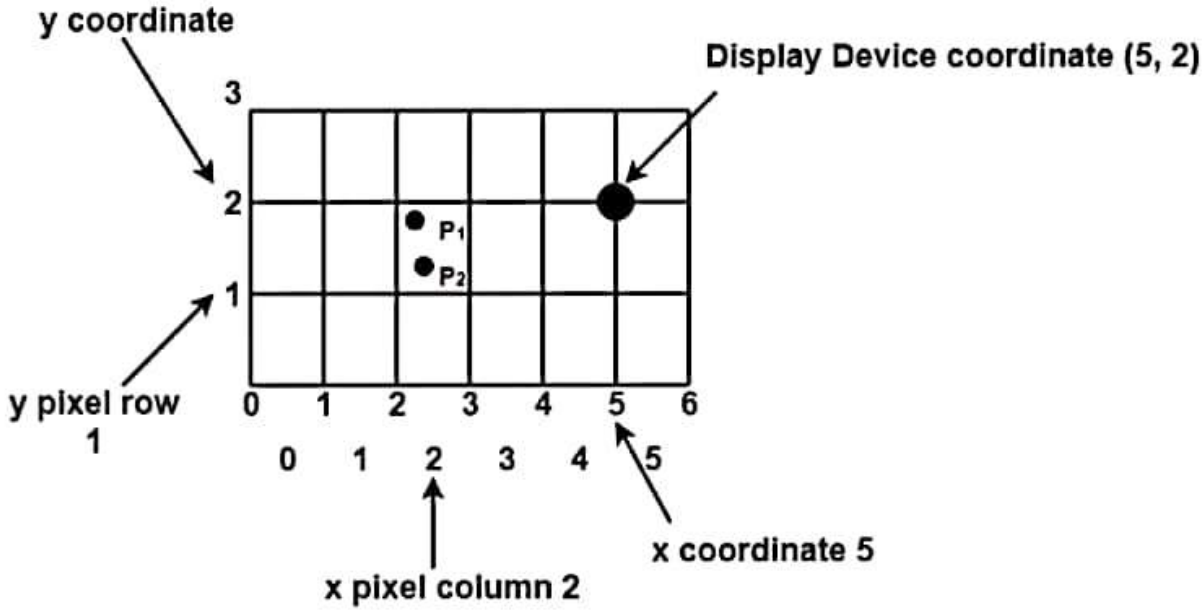
1. Point
2. Line
3. Sector
4. Arc
5. Ellipse
6. Rectangle
7. Polygon
8. Characters
9. Filled Regions

The process of converting is also called as rasterization. The algorithms implementation varies from one computer system to another computer system. Some algorithms are implemented using the software. Some are performed using hardware or firmware. Some are performed using various combinations of hardware, firmware, and software.

Scan Converting a Point

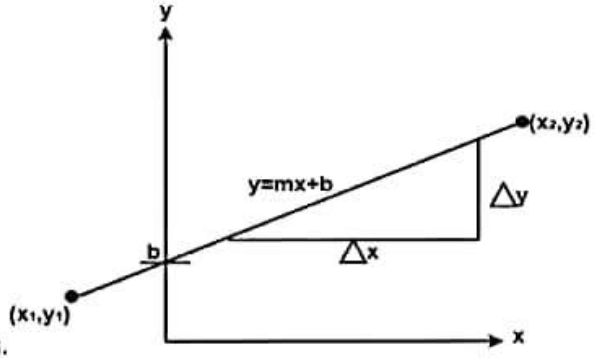
Each pixel on the graphics display does not represent a mathematical point. Instead, it means a region which theoretically can contain an infinite number of points. Scan-Converting a point involves illuminating the pixel that contains the point.

Example: Display coordinates points $P_1\ (2\frac{1}{4}, 1\frac{3}{4})$& $P_2(2\frac{2}{3}, 1\frac{1}{4})$ as shown in fig would both be represented by pixel (2, 1). In general, a point p (x, y) is represented by the integer part of x & the integer part of y that is pixels [(INT (x), INT (y).



Scan Converting a Straight Line

A straight line may be defined by two endpoints & an equation. In fig the two endpoints are described by (x_1,y_1) and (x_2,y_2). The equation of the line is used to determine the x, y coordinates of all the points that lie between these two endpoints.



Using the equation of a straight line, $y = mx + b$ where $m = \frac{\Delta y}{\Delta x}$ & b = the y interrupt, we can find values of y by incrementing x from $x = x_1$, to $x = x_2$. By scan-converting these calculated x, y values, we represent the line as a sequence of pixels.

Algorithm for line Drawing:

1. *Direct use of line equation*
2. *DDA (Digital Differential Analyzer)*
3. *Bresenham's Algorithm*

Algorithm for drawing line using equation:

Step1: Start Algorithm

Step2: Declare variables $x_1,x_2,y_1,y_2,dx,dy,m,b,$

Step3: Enter values of x_1,x_2,y_1,y_2.
The (x_1,y_1) are co-ordinates of a starting point of the line.
The (x_2,y_2) are co-ordinates of a ending point of the line.

Step4: Calculate $dx = x_2 - x_1$

Step5: Calculate $dy = y_2-y_1$

Step6: Calculate $m = \frac{dy}{dx}$

Step7: Calculate $b = y_1-m^* x_1$

Step8: Set (x, y) equal to starting point, i.e., lowest point and x_{end}equal to largest value of x.

If $dx < 0$
then $x = x_2$
$y = y_2$
$x_{end} = x_1$
If $dx > 0$
then $x = x_1$
$y = y_1$
$x_{end} = x_2$

Step9: Check whether the complete line has been drawn if $x=x_{end}$, stop

Step10: Plot a point at current (x, y) coordinates

Step11: Increment value of x, i.e., x = x+1

Step12: Compute next value of y from equation $y = mx + b$

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