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UNIT - 1

* **Computer Graphics** – Computer graphics is an art of drawing lines, pictures, chart etc using computers with the help of programming. Computer graphics is made up of number of pixels. Pixel is the smallest graphical picture or unit represented on the computer screen.

A graphic is an image or visual representation of an object, therefore computer graphics are simplify image display on a computer screen. Graphics are often with text, which is compromise of characters, such as numbers and letters rather than image.

Computer graphics can be either 2-dimensional or 3-dimensional. 2-D graphics comes in two way –

1- Vector graphics
2- Raster graphics

Raster graphics – Raster graphic are the most common and are used for digital photo, web graphics, icons and

other type of image. They are composed of a simple grid of pixels which can in different colour.

Vector graphics – Vector graphics on the other hand are made of paths which may be lines, shapes, letters or other scalable object.

* Interactive Graphics – A computer graphics system that allow the operator to interact with the graphical information presented on the display using one or more of a number of input devices, some of interactive graphics which are aimed at delivering positions relevent to the information being displayed.

* Advantage of interactive computer graphics –

1. Graphics provide one of the most natural means of communicating with a computer, since our highly developed 2-D and 3-D pattern recognition ability allow us to

recieve and process on pictorial data rapidly and effectively.

2. In many design, implementation and construction processing, today the pictures can give responsible information.

3. Creating and reproduce pictures, presented technical problems that stood easy way and interactive computer graphics.

4. Easy to understand.
5. Easy / Simple design.
6. Faster communication
7. Effective result
8. Best solution

* Representative use of computer graphics -

1- User interface - With the help of computer graphics we can create GUI (Graphical User Interface) based.

2- Business, science and technology - In modern days, the use of computer

graphics is in every field of science, technology and business also. With the help of computer graphics we can create pictograph, bar and pie-charts.

3- Computer aided design (CAD) - CAD used for design the structure of any kind of model - buildings, automobile bodies.

4. Simulation and animation - Simulation and animation is used for scientific visualization and entertainment. Some examples of simulation and animation are - flight, games, movies, virtual reality

5- Art and commerce - The use of computer graphics is in art and commerce to find the average design of any kind of information like - terminall of public place like- museum, hotels, shops etc.

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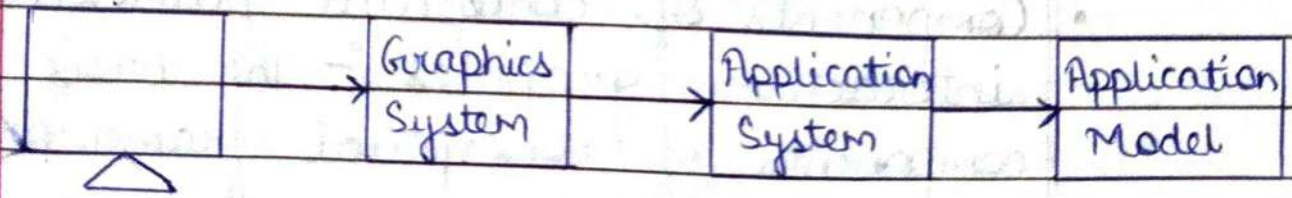
* **Desktop publishing** – Desktop publishing is the use of a computer to produce high quality documents containing text and graphics formatted for a single-page publication.

Example – Desktop publishing is utilized to create printed material such as book covers, brouchure and fliers.

Desktop publishing software can generate layouts and produce typographic quality text and images. Some of the desktop publishing softwares are – Adobe framemaker, Adobe photoshop, Adobe illustrator, Coreldraw etc.

There are two types of pages in desktop publishing – electronic pages and virtual paper pages to be printed on physical paper pages.

* **Conceptual framework of Interactive Graphics :-**



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- **Framework** — In computer graphics, a framework is a layered structure indicating what kind of program can or should be built and how they would be interrelate.
Some computer graphics system framework also include actual program, specify programming interface or offer programming tools for using the framework.

- **Conceptual framework of Interactive graphics** — Conceptual framework compromise of concepts and ideas that are organised and manner in such a way that make communication between graphics application and user with smoothly. It is an organised form of thinking for completing project according to the demand of user and fulfil all the requirements which are demanded by user.

- **Components of conceptual framework of interactive graphics** :- The basic components of conceptual framework are given below -

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1- Graphics library — Graphics library helps between application and displaying hardware (which used to show graphics model).

2- Application program — An application program maps all applications objects to image by invoking graphics.

3- Graphics system — An interface that interact between graphics library and hardware.

* Scan conversation :- Scan conversation is a concept of to calculate the specify slope of any of segment. Scan conversation convert the graphical object according to the needs of user. There are two types of scan conversation —

1. Raster graphics
2. Random (vector) graphics

1. Raster graphics scanning — The raster scan is a scanning technique in graphics monitor where the electron's beam is moved along the scan which screen covering one line at a time from top to bottom. The beam is set as high

and low level as the beam swept around the screen to generate the pattern of illustrate spots. The fundamental unit of raster graphics is known as pixel.

2. Random scanning or vector graphics - Random scanning work in a completely different manner to raster graphics where the electron beam is pointed to merely those area of screen where the picture is to be drawn. However it only involve one line at a time when join a picture that is also known as vector graphics. The electron beam is made to point only toward the part of the screen where the picture is to be drawn.

- Difference between Raster graphics and vector graphics scan (display)

Basis of comparision	Raster scan	Random scan
1- Electron beam	Swept across the screen and hande one row at a	Directed to the portion of the screen where a picture

		time and in downward direction	is to be spot.
2-	Resolution	Poor, since it generate lines which are organised as point sets.	Good, as this produce even line drawing.
3-	Picture definition	Store as the combination of intensity values of all screen points.	Store as a group of line drawing instruction in a display file.
4-	Realistic display	Effectively raster scan show the realistic display.	Unable to display realistic but display the shaded display.
5-	Picture rendering (Basic unit)	Raster scan uses the pixels.	With the help of mathematical functions, show the raster scan display.

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★ **DDA Algorithm** – In computer graphics a digital differential analyzer (DDA) is hardware or software used for interpolation of variables over an interval between start and end point. DDA's are used for rasterization of lines, triangles and polygons.

Digital Differential Analyzer (DDA) algorithm is the simple line generation algorithm which is explained step by step here –

Step 1– Get the input of two end points (X_0, Y_0) and (X_1, Y_1).

Step 2– Calculate the difference between two end points.

$$d_x = X_1 - X_0$$
$$d_y = Y_1 - Y_0$$

Step 3– Based on the calculated difference in step 2, you need to identify the number of steps to put pixel. If $dx > dy$, then you need more steps in x coordinate, otherwise in y coordinate.

```
if (absolute(dx) > absolute(dy))
    steps = absolute(dx);
else
```

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steps = absolute(dy);

Step4- Calculate the increment in x coordinate and y coordinate.

```
x increment = dx/(float) steps;
y increment = dy/(float) steps;
```

Step5- Put the pixel by successfully incrementing x and y coordinate accordingly and complete the drawing of the line.

```
for(int v=0; v<steps; v++)
{
    x = x + X increment;
    y = y + Y increment;
    putpixel(Round(x), Round(y));
}
```

* Bresenham's Line generation -

The Bresenham's algorithm is another incremental scan conversion algorithm. The big advantage of this algorithm is that, it uses only integer calculations. Moving across the x axis in unit intervals and at each step choose between two different y coordinates.

Step1- Input the two end-points of line, storing the left end point in (x_0, y_0).

Step2- Plot the point (x_0, y_0).

Step3- Calculate the constants dx, dy, 2dy and

$(2dy - 2dx)$ and get the first value for the decision parameter as -

$$P_0 = 2dy - dx$$

Step 4- At each x_k along the line, starting at $k=0$, perform the following test -

If $P_k < 0$, the next point to plot is $(x_k + 1, y_k)$ and

$$P_{k+1} = P_k + 2dy$$

Otherwise,

$$(x_k, y_k + 1)$$

$$P_{k+1} = P_k + 2dy - 2dx$$

Step 5- Repeat step 4 $(dx - 1)$ times.

For $m > 1$, find out whether you need to increment x while incrementing y each time.

After solving, the equation for decision parameter P_k will be very similar, just the x and y in the equation gets interchanged.

* **Scan converting line :-**

DDA algorithm - The goal of any line drawing or scan is to construct the best possible approxim

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-tion of an ideal line given limitation of a raster display.

DDA algorithm is an incremental scan conversion method. Here we perform calculation at each step using the result from the previous step. The characteristics of the DDA algorithm to take unit step along one coordinate and compute the corresponding values along the other coordinate.

DDA algorithm is a scan conversation line algorithm based on the calculating Δx and Δy.

where $\Delta x = x_2 - x_1$ and $\Delta y = y_2 - y_1$.

The basic formula of DDA algorithm is -

$$\text{slope}(M) = \frac{y_{end} - y_{start}}{x_{end} - x_{start}}$$

There are 3 possible values of M.-

M	x_{k+1}	y_{k+1}
$M < 1$	$x_{k+1} = x_k + 1$	$y_{k+1} = y_k + M$
$M = 1$	$x_{k+1} = x_k + 1$	$y_{k+1} = y_k + 1$
$M > 1$	$x_{k+1} = x_k + \frac{1}{M}$	$y_{k+1} = y_k + 1$

where k = next co-ordinate

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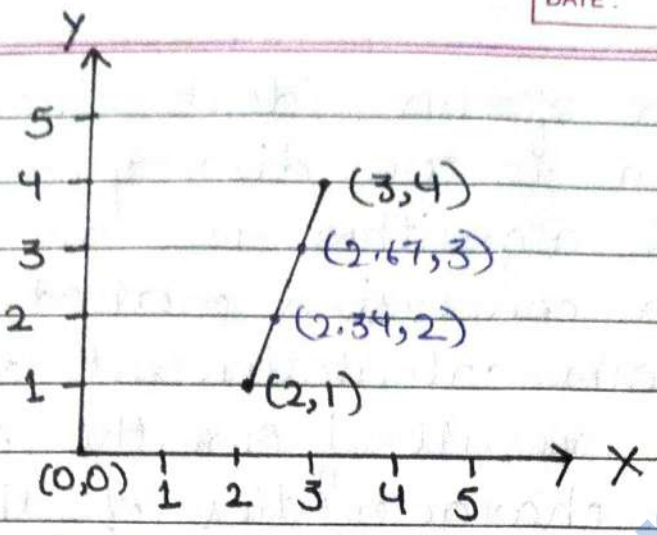
Exc-



$\text{slope}(M) = \frac{4-1}{3-2} = 3$

$x_{k+1} = 2 + \frac{1}{3}$ $(x=2, y=1)$

$= \frac{6+1}{3} = \frac{7}{3} = 2.34$

$y_{k+1} = 1+1 = 2$

$\text{slope}(M) = \frac{4-2}{3-2.34}$

$= \frac{2}{0.66} = 3.03$

$x_{k+1} = 2.34 + \frac{1}{3.03}$

$= 2.67$

$y_{k+1} = 2+1$

$= 3$

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★ Scan converting circle :- Converting the unbroken graphical object as a group of objects is called scan conversion. In the process of scan converting of a circle, the circle is divided into 8 equal parts from the centre point of the circle. One part is called octant and if one part is generated then it is easy to scan the other seven parts. So computing the one octant it is enough to determine (scan) the other parts also.

Techniques use to compute octant – There are several types of techniques or method in scan converting circle is given below

1- DDA algorithm
2- Direct or polygon approach
3- Parametric and trignometric approach.
4- Bresenham's algorithm
5- Mid point circle algorithm

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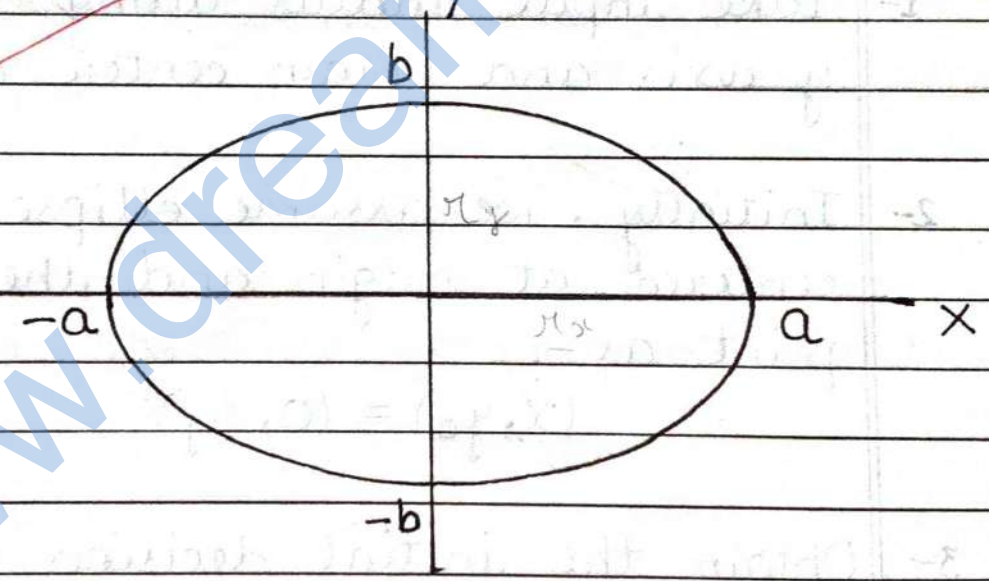
Scan Converting Ellipse

Mid-point ellipse algorithm is used to draw an ellipse in computer graphics. Midpoint ellipse algorithm plots points of an ellipse on the first quardrant by dividing the quardrant into two regions. Each point (x,y) is then projected into other three quardrants $(-x,y)$, $(x,-y)$, $(-x,-y)$ i.e., it uses 4-way symmetry.



$$F(X,Y) = b^2X^2 + a^2Y^2 - a^2b^2 = 0$$

If you draw only the points of the first quardrant then by symmetry you can obtain the other three quardrants.

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Decision parameter –

Initially, we have two decision parameters $p1_0$ in region 1 and $p2_0$ in region 2.
These parameters are defined as: $p1_0$ in region 1 is given as:

$$p1_0 = \frac{r_y^2 + 1}{4r_x^2 - r_x^2 r_y}$$

Mid-Point Ellipse Algorithm –

1- Take input radius along x axis and y axis and obtain center of ellipse.

2- Initially, we assume ellipse to be centered at origin and the first point as –

$$(x, y_0) = (0, r_y)$$

3- Obtain the initial decision parameter for region 1 as –

$$p1_0 = r_y^2 + 1 / 4r_x^2 - r_x^2 r_y$$

4- For every x_k position in region 1:
If $p1_k < 0$ then the next point along is (x_{k+1}, y_k) and

$$p1_{k+1} = p1_k + 2r_y^2 x_{k+1} - 2r_x^2 y_{k+1} + r_y^2$$

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5- Obtain the initial value in region 2 using the last point (x_0, y_0) of region 1 as:

$$p2_0 = r_y^2(x_0 + 1/2)^2 + r_x^2(y_0 - 1)^2 - r_x^2 r_y^2$$

6- At each y_k in region 2 starting at $k=0$ perform the following type-
If $p2_k < 0$ the next point is (x_k, y_{k+1}) and

$$p2_{k+1} = p2_k - 2r_x^2 y_{k+1} + r_x^2$$

7- Else, the next point is (x_{k+1}, y_{k-1}) and

$$p2_{k+1} = p2_k + 2r_y^2 x_{k+1} - 2r_x^2 y_{k+1} + r_x^2$$

8- Now obtain the symmetric points in the three quardrants and plot the coordinate values as:

$$x = x + xc, \quad y = y + yc$$

9- Repeat the steps for region 1 until

$$2r_y^2 x \& gt = 2r_x^2 y$$