

Computer Graphics

- Computer graphics is an art of drawing lines, pictures, charts etc. using computer with the help of programming. Computer graphics images is made up of number of pixels. Pixel is the smallest addressable graphical unit represented on the computer screen.
- In graphics pictures are collection of discrete pixels.

Rasterization : The special procedure determining which pixel will provide the best approximation to the desired picture.

Scan Conversion : - The process of representing continuous picture on graphics object as a collection of discrete pixels is known as scan conversion.

Advantages :-

- ① effective way to communicate with computer,
- ② provide tools for producing picture of real world,
- ③ possible to produce animations.
- ④ provide tools called motion dynamics,
- ⑤ provide tools called update dynamics.



* Application of computer graphics:-

- ① User Interface:- Pictures we see on screen.
- ② Plotting of graphs & chart-
- ③ used for drawing structures of building etc.
- ④ office automation & develop publishing.
- ⑤ Animation
- ⑥ Art & commerce.
used to make financial, economical model.
- ⑦ Image processing.
- ⑧ used in cryptography.

display devices

→ are output devices used to display images.

① Cathode Ray Tube

→ Components:-

① Screen

② Base filament (cathode plate)

③ Electron Gun control grid

④ Focusing system (top-bottom)

⑤ Horizontal & vertical deflection Plates

⑥ Phosphorescence coated screen.
(left-right)

Phosphorescence:- intensity slower by time.

- CRT is a specialized vacuum tube in which images are produced when an electron beam strikes on phosphorus coated screen.
- Technology used in traditional computer, monitor & TV.

Cathode :- cylindrical metallic structure from which electrons are emitted/directed towards phosphorus screen,

Control grid :- covers cathode leaving small opening for electrons to come out.

- control flow of electrons.
- intensity of electron beam.
- High negative voltage applied to control grid with aim of electron beam.
- control intensity of spot on screen.

* focusing system :- used to create a clear picture by forming fine electron into a narrow beam.

* deflection system :- deflection system directs the beam which decides the point where beam strikes the screen, consists of horizontal & vertical deflecting plate.



→ Techniques for producing Images on CRT screen.

| Raster Scan

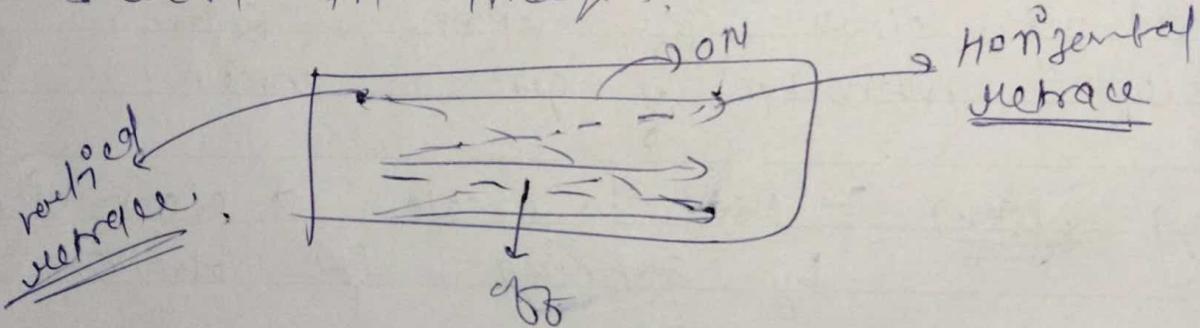
| Vector/Random Scan.

① Raster Scan :-

most common methods of drawing images on the CRT, TV are based on CRT.

In raster scan electron beam sweep across the screen ~~for~~ one row at a time from top-left to right-bottom

In this method the horizontal & vertical deflection signals are generated to move the beam all over the screen as shown in image.

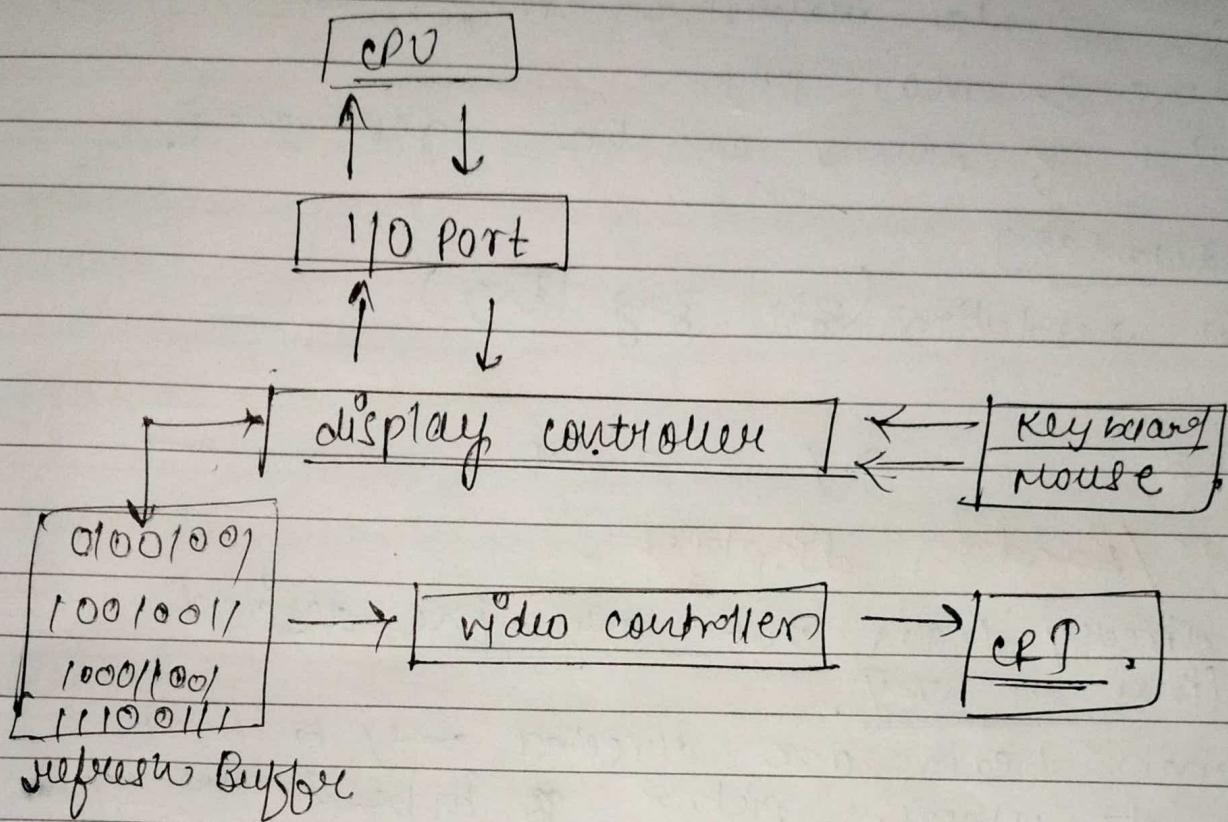


left - to - right → beam ON

right - to - left → beam OFF.

Refreshing of Screen :- The screen is maintained by repeatedly scanning the same image & this is known as refreshing of screen.

Architecture



Refresh Buffer

The display image is stored in the form of 1's & 0's, in the refresh Buffer.

It is special area in memory dedicated to graphics only, it holds the set of intensities of all screen points.

Pixel :- In black/white each pixel is either on or off. Only 1 bit is required to show.

frame buffer = bitmap

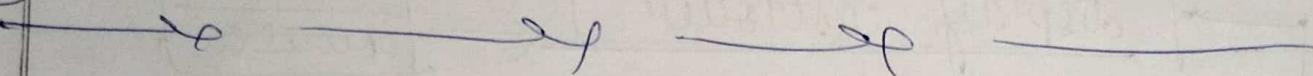
24 bits per pixel → multiplex colors

Advantages

- ① It is suitable for realistic images containing shades & color pattern.
- ② Millions of colors can be generated.

Disadvantage

- ① Low resolution (Zig-Zag Ring)

Vector / Random Display

- It directly traces out only the desired lines on CRT.
- Electron beam are directed only to that part where picture is to be drawn.
- If we want line b/w P1 & P2 then we directly drive the beam deflection circuitry which focus beam directly to new points.

Architecture :-

display buffer :- display file containing commands instead of intensity

containing display list -

→ character plotting commands

display controller :- connected as I/O peripheral to CPU.

→ display controller interprets command of display buffer &

sends digit & point coordinate to vector generator

Teacher's Signature :

vector generator converts digit coordinate to analog voltage for beam deflection circuit.

→ In this beam is deflected by two random points hence it is known as random scan.

→ flicker :- variation of intensity on screen.

- advantage → ① smooth display
② high resolution

disadvantage → ① expensive
② cannot display realistic shades,

* Color CRT monitors :-

CRT monitor display color picture by using a combination of phosphorescent material emitting different colors of light.

R, B, G → coated phosphorescence

Techniques → Beam penetration
shadow mask,



* Beam penetration Technique

- used in Random Scan monitors.
- In this technique inside of CRT coated with two phosphorescent layers.
 - Outer → red
 - Inner → green.
- High speed electron penetrates green layer.
- Low speed electron penetrates red layer.
- At intermediate beam speed we can produce combination of red & green light which emit orange & yellow color.
- Beam acceleration voltage controls speed of electron & hence color of pixel.

disadvantages → ① only 4 colors are displayed,
② quality of picture is not so good.

* Shadow mask Technique -

It produces wide range of colors as compared to beam penetration technique. Used in Roasten Scan display monitors.

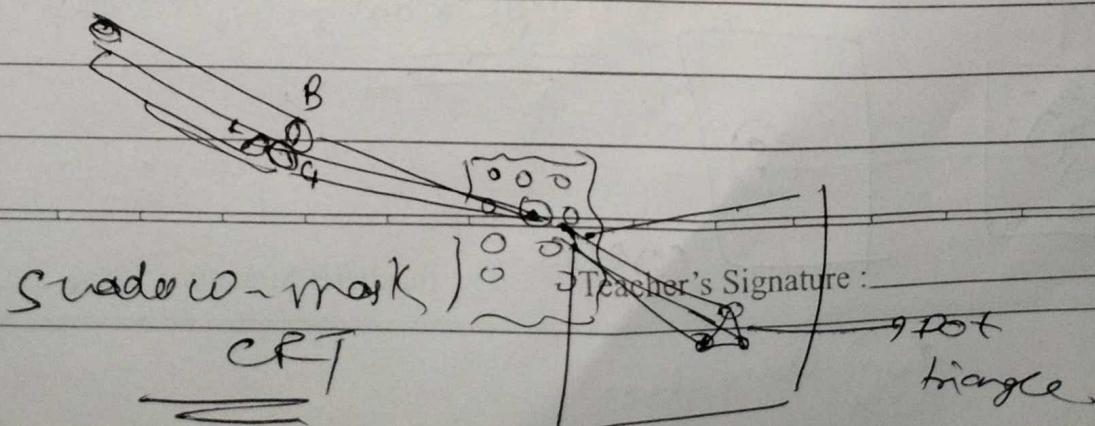
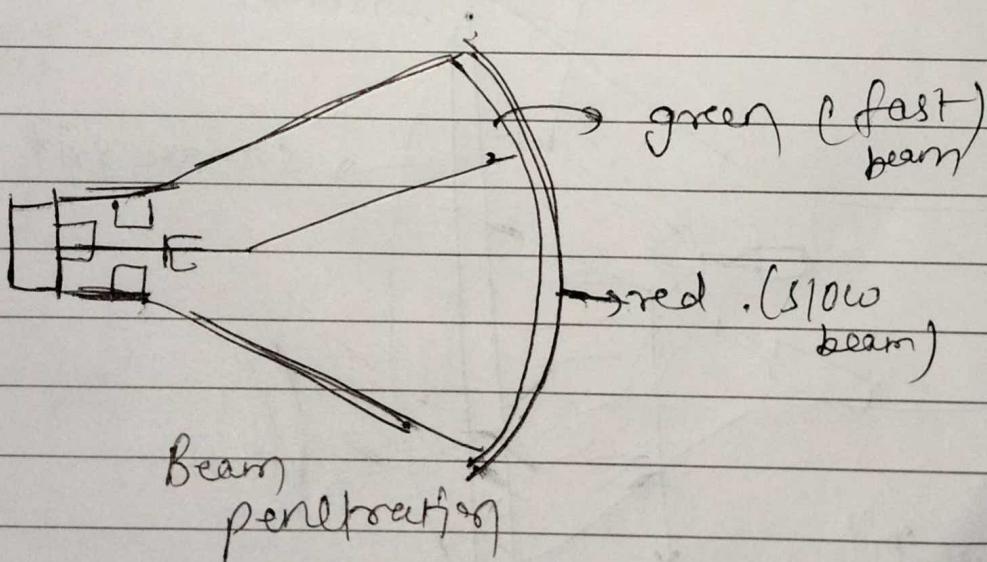
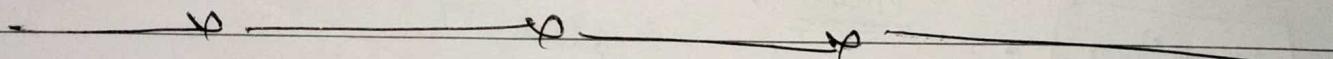
- consists of three electron guns.
- Red, Blue, Green can excite respective phosphorescent color screen.

→ In this CRT has three phosphorus color dots at each triangle. pixel position . In form of red green , blue

→ There is shadow mask grid just behind phosphor coated screen.

→ shadow mask contain series of holes.

→ By changing the intensity of three electron beam we can get different colors in shadow mask.





(2) Direct View Storage Tube.

In CRT based refreshing was required. To reduce this DVST was introduced
→ containing two guns.
 → Primary gun
 → Flood gun.

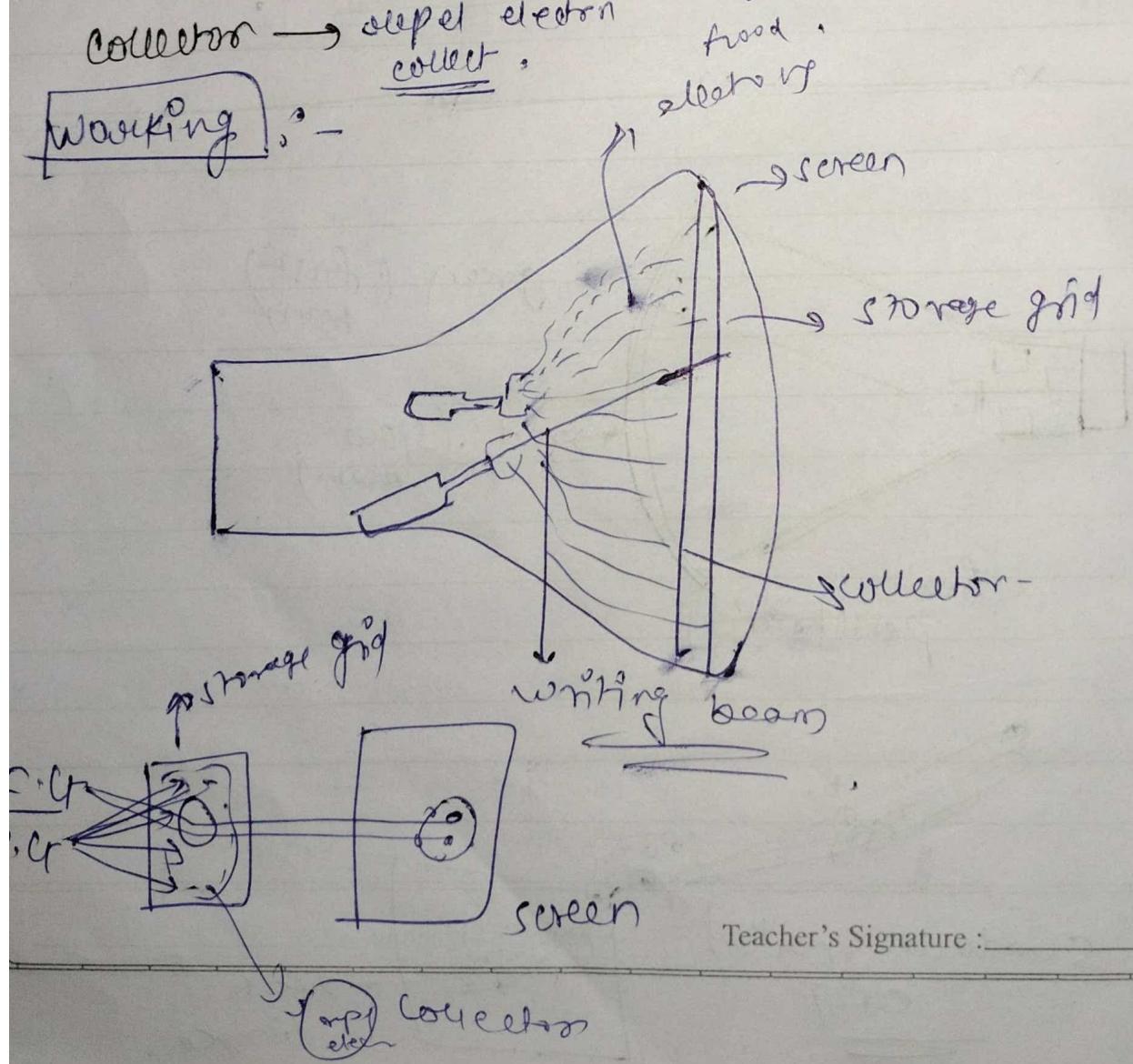
Primary gun → store the pattern of picture we want to draw on screen.

Flood gun → emit slow speed electrons.

Storage grid → stores the image to be drawn on screen, so refreshing is not required.

Collector → collect electron

Working :-



Advantages :-

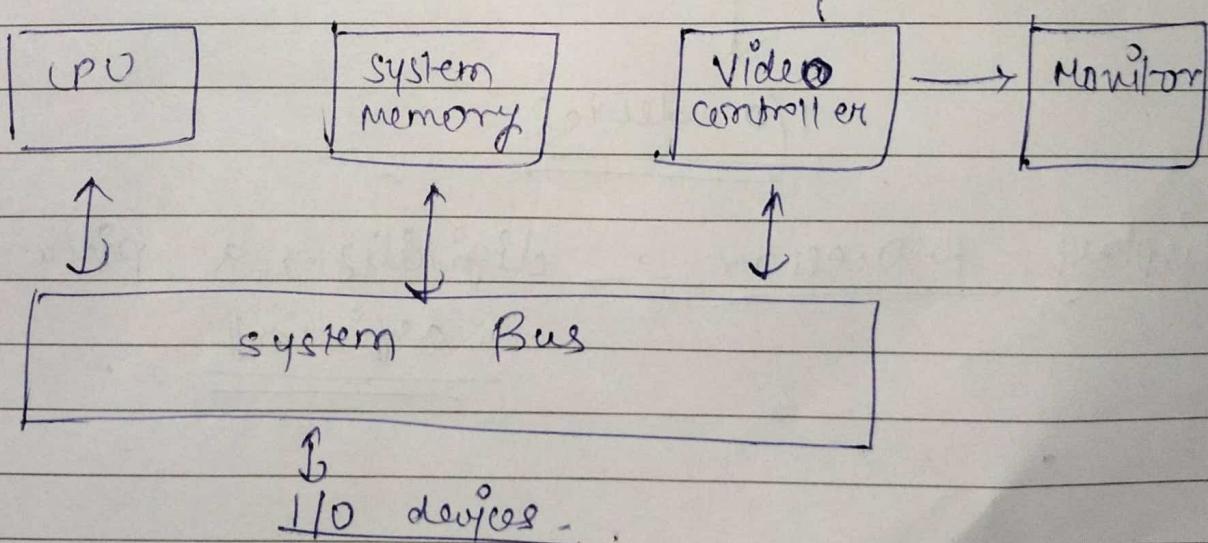
- ① Picture can be drawn for 40 - 50 minutes before fading.
- ② Refreshing is not required.
- ③ Complex picture can be drawn with high resolution.
- ④ Flat screen.

Disadvantages :-

- ① Not display color.
- ② Erasing takes time.
- ③ Erasing selective part is not possible.

* Faster graphics :-

Simple :-



→ frame buffer can be anywhere in the system memory.

Teacher's Signature: _____

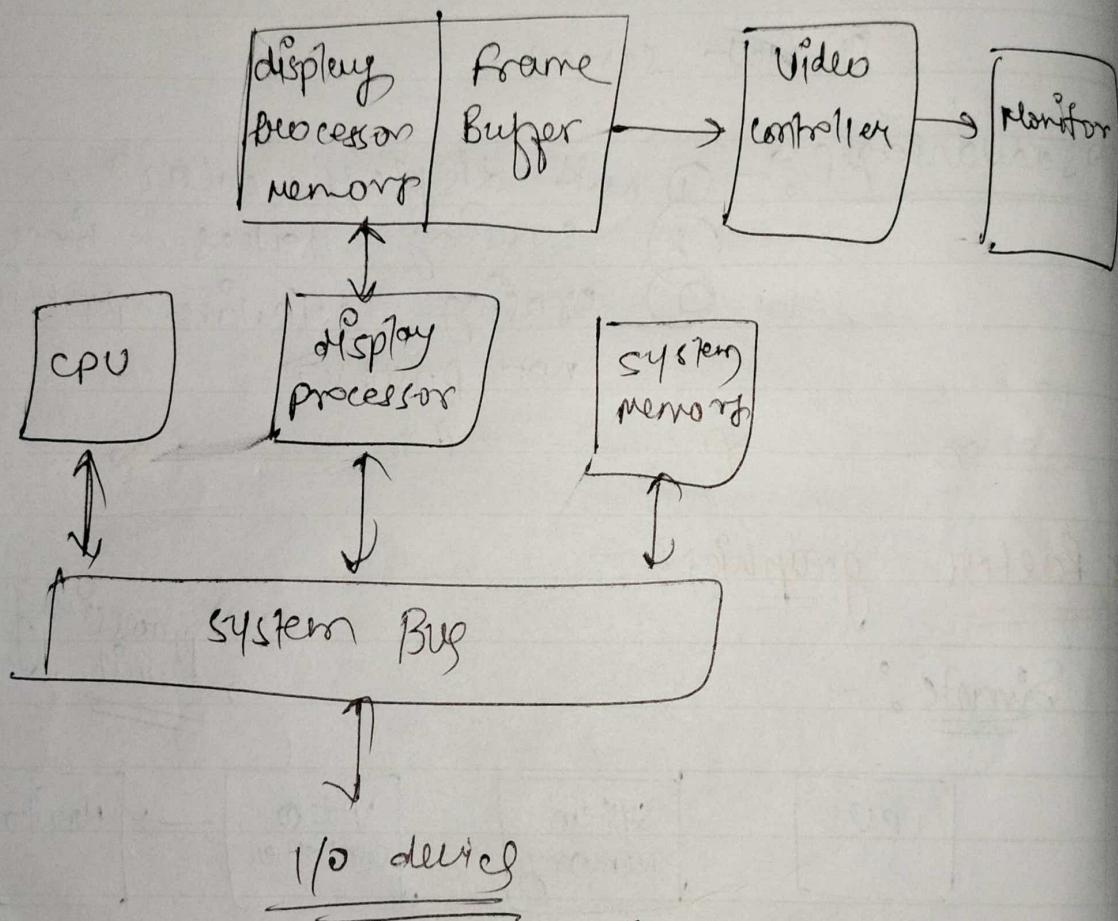


Experiment Name

* Raster - graphics system with display

Processor :-

→ One way of designing raster system is having separate display coprocessor.



display processor :- digitizing a picture
defining

Teacher's Signature :

YF | Line drawing Algorithm |

DDA :- Digital Differential Algorithm,

- incremental method to draw line
- calculation ^{out} each step but using previous result, performed
- plotting of same point ~~&~~ (twice) is not possible.
- repeat till end point.
- Simplest / Faster method / algorithm for pixel position

~~Init.~~ procedure :-

$$(x_1, y_1) \quad \& \quad (x_2, y_2)$$

$$dx = x_2 - x_1$$

$$dy = y_2 - y_1$$

length of line :- $\text{abs}(dx) \geq \text{abs}(dy)$

$$\text{length} = \text{abs}(dx)$$

else length $\geq \text{abs}(dy)$

$$x_{\text{inc}} = \frac{dx}{\text{length}}$$

$$y_{\text{inc}} = \frac{dy}{\text{length}}$$

Teacher's Signature : _____



$$x = x_1$$

$$y = y_1$$

`setpixel(round(x), round(y));`

`for(i=1; i<length; i++)`

`{`

$$x = x + x_{inc};$$

$$y = y + y_{inc};$$

`setpixel(round(x), round(y));`

`}`

end

disadvantages - ① takes lot of computations

② floating point calculation &
rounding operation is
expensive.

$$(x_1, y_1) = (0, 0)$$

$$(x_2, y_2) = (6, 7)$$

$$dx = 6 \quad dy = 7$$

$$\boxed{\text{length} = 7}$$

$$x_{inc} = \frac{6}{7} = 0.87 \quad y_{inc} = \frac{7}{7} = 1$$

Teacher's Signature :

i	x	y	Line(x, y)
1	0	0	(0, 0)
2	0.857	1	(1, 1)
3	1.714	2	(2, 2)
4	2.571	3	(3, 3)
5	3.428	4	(3, 4)
6	4.285	5	(4, 5)
7	5.142	6	(5, 6)
8	5.999	7	(6, 7)

② Bresenham's Line Algorithm:-

To remove drawback of DDA. It is more accurate & efficient method / algo.

→ It involves only integer addition, subtraction, multiplication algorithm.

→ Lines are generated quickly, because operation are rapid:

→ In this algorithm, moving across x-axis in unit interval & each step choose b/w two diff. y coordinates

→ select point that is closer to original line.



Experiment Name

$$m = \text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$$

decision variable (P_{IC})

\boxed{m}

$m \leq 1$

$m > 1$

$$P_R = \Delta y - \Delta x$$

$$P_{IC} = \Delta x - \Delta y$$

$P_{R \leq 0}$

$P_{K > 0}$

$P_{\leq 0}$

$P_{>, 0}$

$$x_{K+1} = x_K + L$$

$$x_{K+1} = x_K + 1$$

$$\frac{x}{y+1}$$

$$x+1$$

$$y_K = y_K$$

$$y_K = y_K + 1$$

$$P_{K+1} = P_K + 2\Delta y$$

$$P_{K+1} = P_K + 2\Delta y - 2\Delta x$$

$$\underline{P = P + 2\Delta x}$$

$$\underline{P = P + 2\Delta x - 2\Delta y}$$

Teacher's Signature :