ॐ 6CS4A ①

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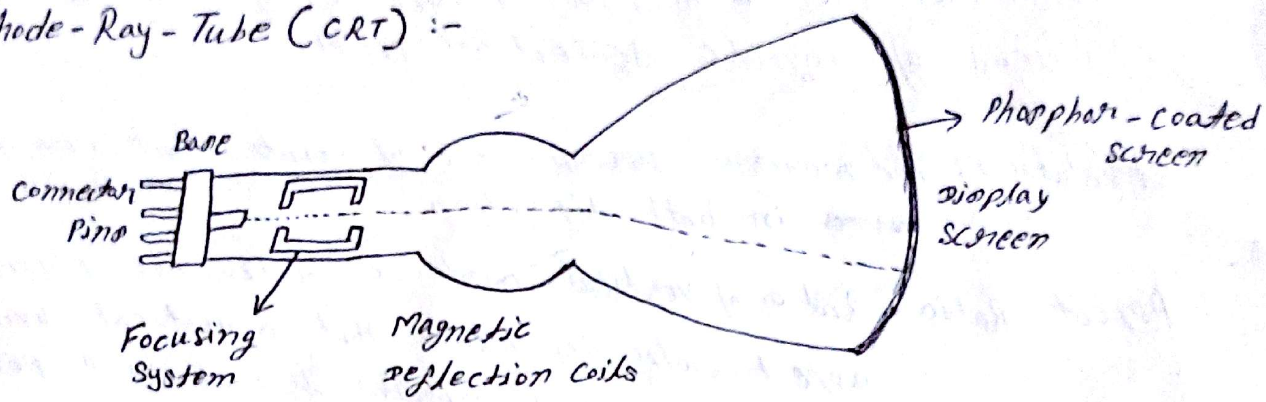
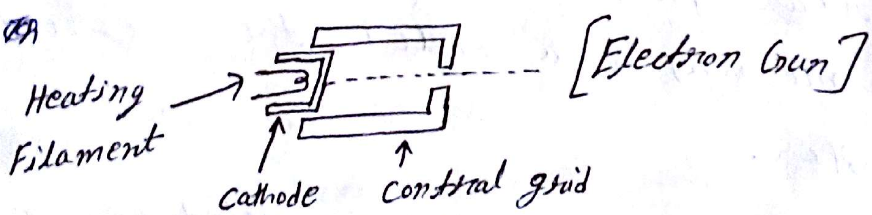
* Video Display Device :-

The primary output device in a graphics system is a video monitor. The operation of video monitor is based on the Cathode-Ray-Tube (CRT).

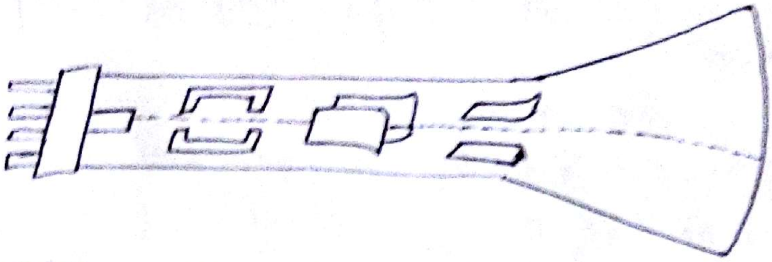
Cathode-Ray-Tube (CRT) :-



1) It is a ~~display~~ ~~scr~~ Vaccume tube with a display screen at one end and connector at the other end to control circuit.
2) Display Screen coated with special material called phosphor, which emits light for a period of time, when hit by a beam of electron.
3) The electrons are regulated by the electron gun.
4) It passes through focusing & deflection systems that direct the beam toward specified positions on the phosphor coated screen.



5) The primary components of an electron gun are the heated metal cathod and control grid.
6) Heat is Supplied to the cathode by directing a current through a coil of wire, called filament. The negatively charged electron are then accelerated towards the screen.
7) Intensity of the electron beam is controlled by setting voltage levels on the control grid.



8) Some CRT uses ~~a~~ horizontal & vertical deflection plates instead of magnetic deflection coils.

Resolution: The maximum ~~no~~ number of points that can be displayed ~~on a~~ in both direction.

Aspect Ratio: Ratio of vertical points to horizontal points. An aspect ratio 3/4 means that a vertical line plotted with 3 points & horizontal line with 4 points have same length.

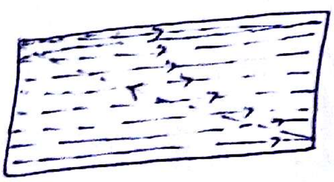
* Raster Scan Display :- Refer Page No. - 14

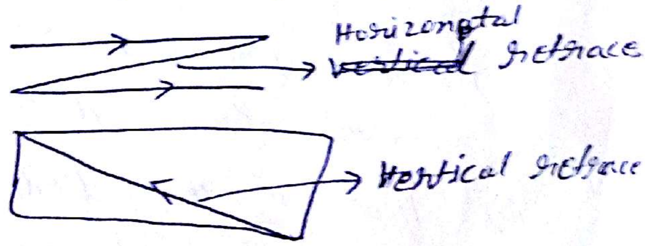
CRT is operated by two methods -

1) Raster scan display
2) Random Scan display

In raster scan system, the electron beam moves one row at a time from top to bottom. As electron moves, the beam intensity is turned on and off to create pattern. Picture defination is stored in a memory area called the refresh buffer or frame buffer.

Refresh Rate :- How many frames completed per second.



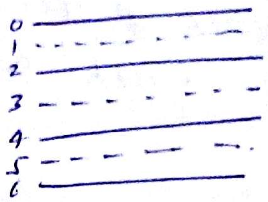


* Random Scan Display :-

In this, a CRT has electron beam directed only to the parts of the screen where a picture is to be drawn.

* Flicking :- When refresh rate is too slow, then flickers occure.

* Interlacing :-



Each frame is displayed in two passes. In the first pass, the beam sweeps scan line from top to bottom.

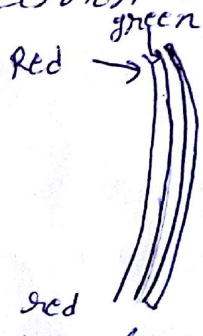
Then after the vertical retrace, the beam sweeps out the remaining scan lines.

This is effective technique to avoid flicker, providing that adjacent scan lines contain similar display information.

* Color Monitor :- A CRT color monitor display color pictures by using a combination of phosphors that emits different colored light. There are two techniques –

1) Beam - penetration
2) Shadow - mask method.

1) Beam - Penetration :- It is used with random - scan monitor.
There are two layers of phosphors - Red & green.
Displayed color depends on how far the electron beam penetrates into the phosphor layers.



Beam of slow speed electron excites red layer
" fast " " green "

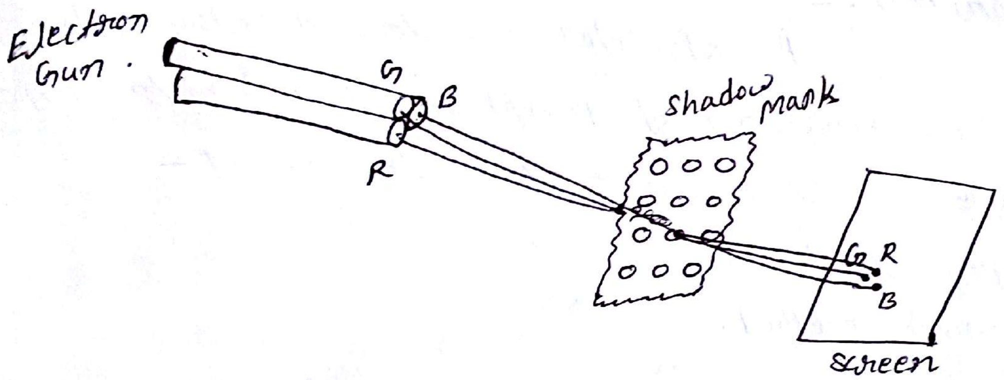
At intermediate beam speed combination of red & green light are emitted & show two additional color - orange & yellow.

Disadv. :- There are only four colors are possible & the quality of pictures is not good as with shadow mask method.

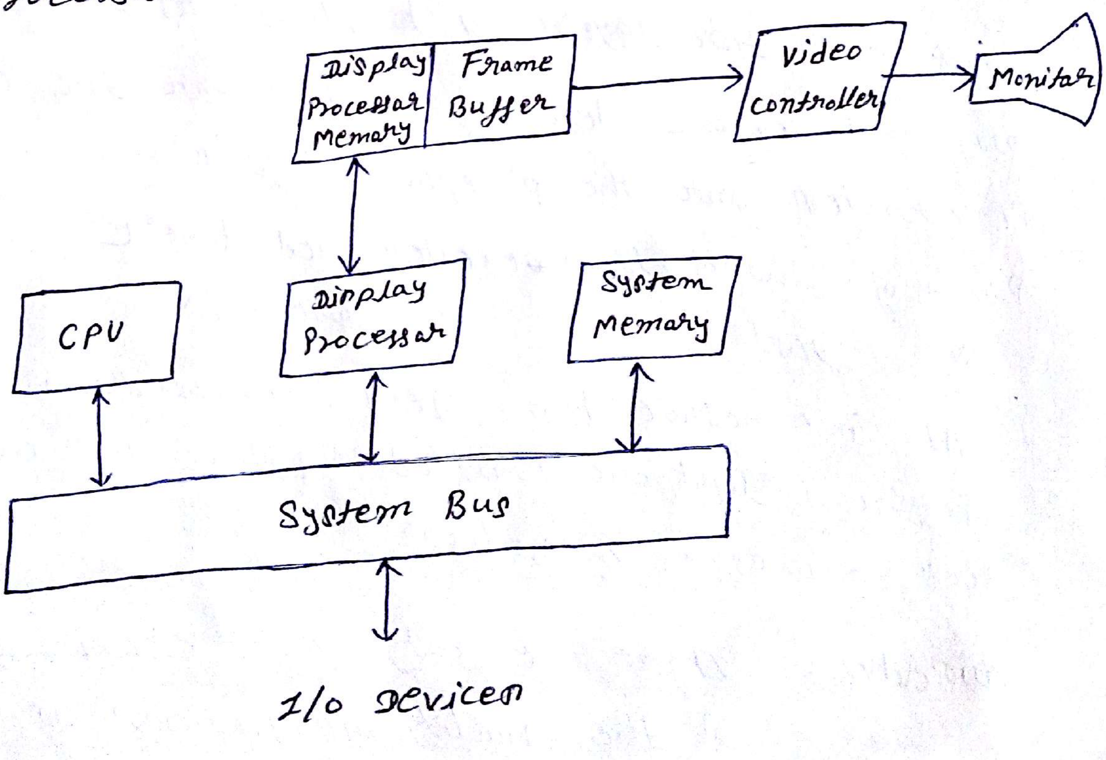
2) Shadow-Mask Method :- It is used in raster-scan system. It produce wider range of colors. It has three ~~layer~~ phosphor color dots at each pixel position - red, green & blue. This type of CRT has three electron gun - one for each color dot & shadow-mask grid just behind phosphor coated screen.

When three beams passes through a hole in the shadow mask, they activate a dot triangle, which appears as a small color spot on the screen.

The phosphor dots in the triangle are arranged so that each electron beam can activate only its corresponding color dot when it passes through the shadow mask.



* Display Processor :-



Raster scan system typically ~~et~~ employ several processing units like CPU, system memory, display processor, video controller etc.
Video controller is used to control the operation of display device. The purpose of display processor is to free the CPU from graphics system. Major task of display processor is digitizing a picture information into a pixel intensity value for storage in the frame buffer. This digitizing process is called scan conversion.

* Scan Conversion :-

Scan conversion is a process of digitizing the picture information into a pixel intensity value and store it in the frame buffer. Points and straight line segment are the simplest geometric components of pictures; other primitives that can be used to construct pictures are circle, spline curves, polygon, character strings etc.

POINT :-

Point plotting is accomplished by converting a single coordinate position into appropriate operations for the output device. With a CRT monitor, the electron beam is turned on to illuminate the screen phosphor at the selected location.

In raster scan system coordinate values are stored in instructions and these coordinate value are converted into deflection voltages that position the electron beam at the screen location.

LINE :-

Line drawing is accomplished by calculating ~~intermedi~~ intermediate positions along the line path between two specified end points positions.

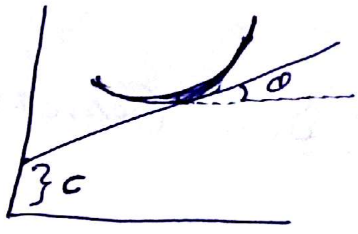
Digital devices display a straight line segment by plotting discrete points between the two end points. Discrete coordinate positions along the line path are calculated from the equation of the line.

To load a coordinate of point into the frame buffer :- setpixel (x, y);

Equation for straight line –

$$y = mx + c$$

where $m \rightarrow$ slope of the line
$c \rightarrow$ the y intercept



$m = \tan\theta$

If two end points of line are (x_1, y_1) & (x_2, y_2), then –

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$c = y_1 - mx_1$$

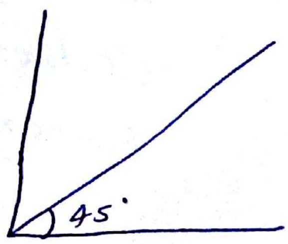
For any Δx interval at x, we can compute the corresponding Δy interval –

$$\Delta y = m \cdot \Delta x$$

Similarly, Δx can be computed by Δy as -

$$\Delta x = \frac{\Delta y}{m}$$

when $m < 1 \Rightarrow$ ~~Δx~~ we sample at unit x interval and compute corresponding y value.



$m = \tan 45° = 1$

$m > 1 \Rightarrow$ we sample at unit y interval and compute corresponding x value.

if $m = 1 \Rightarrow$ Both x & y are sample at unit interval.

$$\Delta x = \Delta y = 1$$

1) DDA Algorithm :-

The digital differential analyzer (DDA) is a scan-conversion line algorithm based on calculating either Δy or Δx. We sample the line at unit interval in one coordinate and determine corresponding values for the other coordinate.

If $m \leq 1 \Rightarrow$

$$\Delta x = 1$$
$$\Delta y = m.\Delta x \Rightarrow \Delta y = m$$
$$x_{k+1} = x_k + \Delta x = x_k + 1$$
$$y_{k+1} = y_k + \Delta y = y_k + m$$

If $m > 1 \Rightarrow$

$$\Delta y = 1$$
$$\Delta x = \frac{\Delta y}{m} = \frac{1}{m}$$
$$y_{k+1} = y_k + \Delta y = y_k + 1$$
$$x_{k+1} = x_k + \Delta x = x_k + \frac{1}{m}$$

For +ve slope

If $m \leq 1 \Rightarrow$

$$\Delta x = -1$$
$$x_{k+1} = x_k - 1$$
$$y_{k+1} = y_k - m$$

If $m > 1 \Rightarrow$

$$\Delta y = -1$$
$$y_{k+1} = y_k - 1$$
$$x_{k+1} = x_k - \frac{1}{m}$$

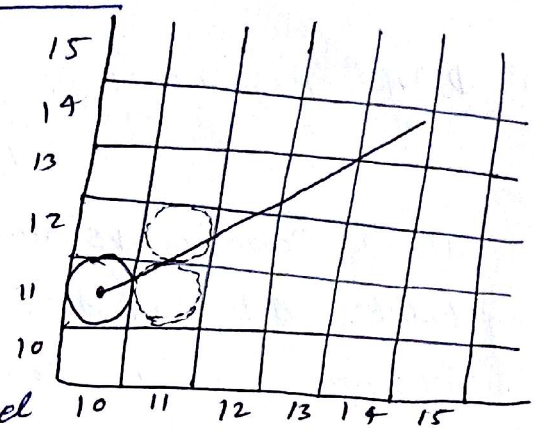
For -ve slope

It uses only integer calculation at each pixel.

2) Bresenham's Line Algorithm :-

In Bresenham's line algorithm, the vertical axes show scan line positions and the horizontal axes identify pixel columns.

Sampling at unit x intervals and decide which of two possible pixel positions is closer ~~is closer~~ to the line path at each sample step.

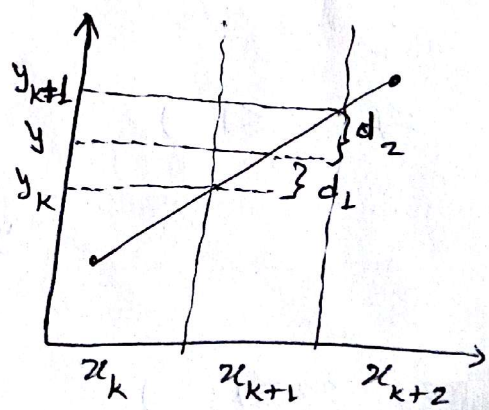


The position of pixel is decided by testing the sign of an integer parameter, whose value is proportional to the difference between the separations of two pixel positions.

Assume we have determined the pixel (x_k, y_k) and need to decide which pixel to plot in column x_{k+1}. Our choices are the pixels at position (x_k+1, y_k) and (x_k+1, y_k+1).

The y coordinate on the mathematical line at pixel column x_{k+1} is calculated as –

$$y = m(x_k+1) + b$$



Then

$$d_1 = y - y_k$$
$$= m(x_k+1) + b - y_k$$

$$d_2 = (y_k+1) - y$$
$$= y_k+1 - m(x_k+1) - b$$

The difference between these two separations is -

$$d_1 - d_2 = 2m(x_k + 1) - 2y_k + 2b - 1$$

A decision parameter P_k for the k^{th} step -

$$P_k = \Delta x (d_1 - d_2)$$

$$P_k = 2\Delta y\, x_k - 2\Delta x\, y_k + 2\Delta y + \Delta x(2b-1)$$

$$P_k = 2\Delta y\, x_k - 2\Delta x\, y_k + C \quad \text{——} \quad (1)$$

If pixel y_k is closer to the line path than $y_k + 1$, so $d_1 < d_2$ and decision parameter P_k is -ve. In that case we plot lower pixel $(x_k + 1, y_k)$; otherwise, we plot the upper pixel $(x_k + 1, y_k + 1)$.

Initially at $k=0$, the first decision parameter P_0 is evaluated from starting pixel position (x_0, y_0) -

From eqn (1) - $\quad P_0 = 2\Delta y\, x_0 - 2\Delta x\, y_0 + C$

where $C = 2\Delta y + \Delta x(2b - 1)$

& $b = y_0 - m x_0$

$$\Rightarrow \boxed{P_0 = 2\Delta y - \Delta x}$$

At step $k+1$, the decision parameter is -

$$P_{k+1} = 2\Delta y \cdot x_{k+1} - 2\Delta x \cdot y_{k+1} + C \quad \text{——} \quad (2)$$

$$(2) - (1) \Rightarrow P_{k+1} - P_k = 2\Delta y(x_{k+1} - x_k) - 2\Delta x(y_{k+1} - y_k)$$

$\because$ unit increment in x direction, so $x_{k+1} = x_k + 1$.

So that, $P_{K+1} = P_K + 2\Delta y - 2\Delta x (y_{K+1} - y_K)$

where the term $y_{K+1} - y_K$ is either 0 or 1, depending on the sign of the parameter P_K.

If $P_K < 0$, then next point is (x_K+1, y_K)

$$\text{So } y_{K+1} - y_K = 0$$

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

If $P_K \geq 0$, then next point is (x_K+1, y_K+1)

$$\text{So } y_{K+1} - y_K = 1$$

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

Algorithm :-

1. Input the two line endpoints and store the left endpoint in (x_0, y_0).
2. Plot the first point (x_0, y_0).
3. Calculate constants Δx, Δy, $2\Delta y$ and $2\Delta y - 2\Delta x$, and obtain the starting value for decision parameter –

$$P_0 = 2\Delta y - \Delta x$$

4. At each x_K along the line, starting from $k=0$, perform the following test –

   i) If $P_K < 0$, next point is (x_K+1, y_K) and

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

   ii) otherwise, next point is (x_K+1, y_K+1) and

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

5. Repeat step 4 Δx times.

Numerical :-

Q: Consider a line from (0,0) to (4,6), use the simple DDA algorithm to make this line.

Sol^n

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

$(x_2, y_2) = (4,6)$

i) $dx = x_2 - x_1 = 4 - 0 = 4$

$dy = y_2 - y_1 = 6 - 0 = 6$

ii) $m = \frac{\Delta y}{\Delta x} = \frac{6}{4} = 1.5$ (+ve slope)

iii) $\because m > 1$

So $\Delta y = 1$ & $\Delta x = 1/m = 0.667$

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

$x_{k+1} = x_k + \frac{1}{m}$

iv) $y_1 = 0$, $x_1 = 0$

$y_2 = 1$, $x_2 = 0 + 0.667 = 0.667$

$y_3 = 2$, $x_3 = 0.667 + 0.667 = 1.334$

$y_4 = 3$, $x_4 = 1.334 + 0.667 = 2.001$

$y_5 = 4$, $x_5 = 2.001 + 0.667 = 2.668$

$y_6 = 5$, $x_6 = 2.668 + 0.667 = 3.335$

$y_7 = 6$, $x_7 = 3.335 + 0.667 = 4.002$

0.002 fractional error

To remove this fractional error, we use Bresenham's line algorithm, which uses only integer value.

Q: Consider a line from (20, 10) to (30, 18), use Bresenham line algorithm to make this line.

Soln i) $(x_0, y_0) = (20, 10)$

$(x_n, y_n) = (30, 18)$

ii) $m = \frac{\Delta y}{\Delta x} = \frac{8}{10} = 0.8$

iii) $\Delta x = 10$, $\Delta y = 8$

The initial decision Parameter -

$P_0 = 2\Delta y - \Delta x$

$P_0 = 6$

iv) For calculating successive decision parameter -

$2\Delta y = 16$ & $2\Delta y - 2\Delta x = -4$

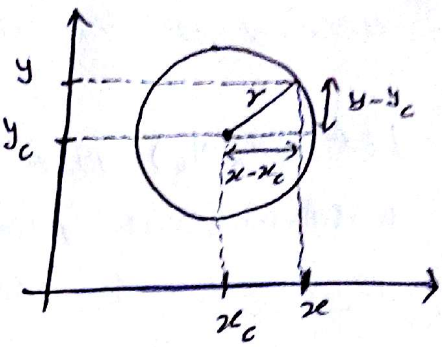
v) Plot the initial point $(x_0, y_0) = (20, 10)$, and determine successive pixel position -

K	P_K	x_{K+1}, y_{K+1}
0	6	(21, 11)
1	2	(22, 12)
2	-2	(23, 12)
3	14	(24, 13)
4	10	(25, 14)
5	6	(26, 15)
6	2	(27, 16)
7	-2	(28, 16)
8	14	(29, 17)
9	10	(30, 18)

CIRCLE ⇒

A Circle is defined as the set of Points that are all at a given distance r from a center Position (x_c, y_c). This distance relationship is expressed by the Pythagorean theorem as –

$$(x-x_c)^2 + (y-y_c)^2 = r^2$$



By using this equation, calculate the Position of Points on a circle at each unit step in x direction from $x_c - r$ to $x_c + r$ and calculate the corresponding y values at each position.

$$y = y_c \pm \sqrt{r^2 - (x-x_c)^2}$$

Midpoint Circle Algorithm :–

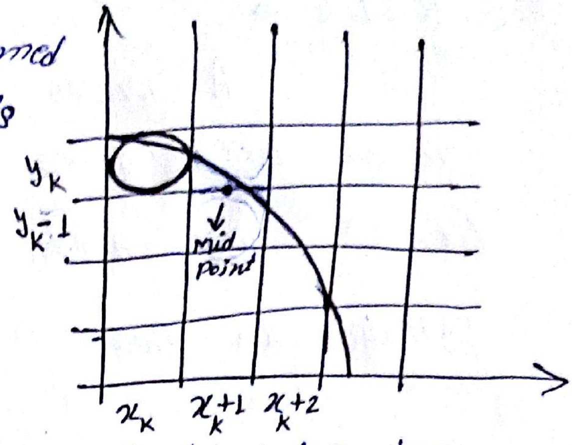
To apply the mid point method, we define a circle function:

$$f_{circle}(x, y) = x^2 + y^2 - r^2$$

The relative position of any Point (x, y) can be ~~determi~~ determined by the sign of the circle function:

$$f_{circle}(x,y) \begin{cases} <0; & \text{if } (x,y) \text{ is inside the circle boundary} \\ =0; & \text{if } (x,y) \text{ is on the circle boundary} \\ >0; & \text{if } (x,y) \text{ is outside the circle boundary} \end{cases}$$

The circle function tests are performed for the mid positions between pixels near the circle path at each sampling step. Thus the circle function is the decision parameter.



Let (x_k, y_k) pixel have plotted, we need to determine ~~whether the pixel~~ the next pixel position, which is closer to the circle is (x_k+1, y_k) or (x_k+1, y_k-1).

This is evaluated by using the midpoint pixel between these two pixels:

$$\text{midpoint} = \left(x_k+1, y_k - \frac{1}{2}\right)$$

So, decision parameter -

$$P_k = f_{circle}\left(x_k+1, y_k - \frac{1}{2}\right)$$

$$P_k = (x_k+1)^2 + \left(y_k - \frac{1}{2}\right)^2 - r^2 \quad \text{—— (1)}$$

If $P_k < 0$; midpoint is inside the circle, so scan line y_k is closer to circle.

otherwise; midpoint is outside or on the circle boundary, so scan line $y_k - 1$ is closer to circle.

The successive decision parameter are obtained by -

$$P_{k+1} = f_{circle}\left(x_{k+1}+1, y_{k+1} - \frac{1}{2}\right)$$

where $x_{k+1} = x_k + 1$ & $y_{k+1} = y_k$ or $y_k - 1$

$$P_{k+1} = \left[(x_k+1)+1\right]^2 + \left(y_{k+1} - \frac{1}{2}\right)^2 - r^2 \quad — (2)$$

(2)−(1) $\Rightarrow$ $P_{k+1} = P_k + 2(x_k+1) + (y_{k+1}^2 - y_k^2) - (y_{k+1} - y_k) + 1$

If $P_k < 0 \Rightarrow$ $(x_{k+1}, y_{k+1}) = (x_k+1, y_k)$

So $\boxed{P_{k+1} = P_k + \underbrace{2x_{k+1}}_{} + 1}$

$$2(x_k+1) = 2x_k + 2$$

If $P_k \geq 0 \Rightarrow$ $(x_{k+1}, y_{k+1}) = (x_k+1, y_k-1)$

So $\boxed{P_{k+1} = P_k + 2x_{k+1} - \underbrace{2y_{k+1}}_{} + 1}$

$$2(y_k - 1) = 2y_k - 2$$

Initially at $k=0$, the decision parameter at pixel position $(x_0, y_0) = (0, r)$ is defined as —

From eqn (1) $\Rightarrow$ $P_0 = f_{circle}\left(1, r - \frac{1}{2}\right)$

$$P_0 = 1 + \left(r - \frac{1}{2}\right)^2 - r^2$$

$$\boxed{P_0 = \frac{5}{4} - r}$$

~~Algorithm:-~~

Q: Given a circle radius $r = 10$, determine positions along the circle octant in first quadrant from $x = 0$ to $x = y$.

Sol^n The initial value of decision parameter is —

$$P_0 = \frac{5}{4} - r$$

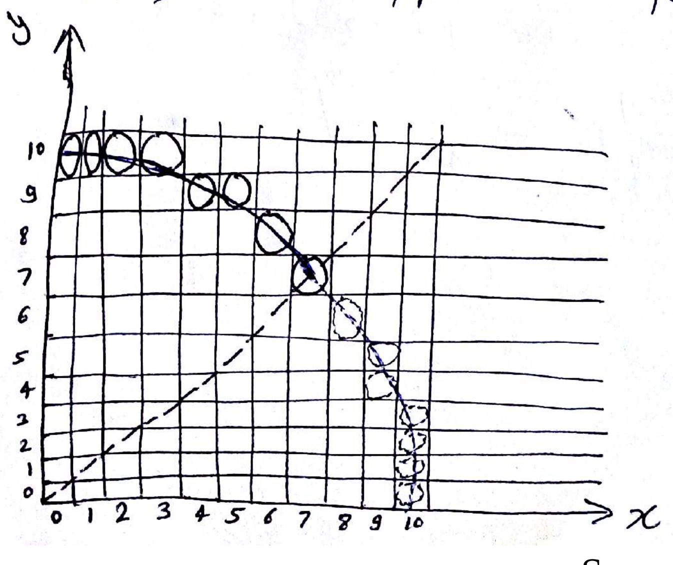
$$P_0 = \frac{5}{4} - 10$$

$$P_0 \approx -9$$

For the circle centered on the origin, the initial point is $(x_0, y_0) = (0, 10)$.

Successive positions along the circle path are calculated using the midpoint method —

k	P_k	(x_{k+1}, y_{k+1})	$2x_{k+1}$	$2y_{k+1}$
0	-9	(1, 10)	2	20
1	-6	(2, 10)	4	20
2	-1	(3, 10)	6	20
3	6	(4, 9)	8	18
4	-3	(5, 9)	10	18
5	8	(6, 8)	12	16
6	5	(7, 7)	14	14



Algorithm:-

1) Input radius r and circle center (x_c, y_c), and obtain first point on the circumference of a circle centered on the origin as

$$(x_0, y_0) = (0, r)$$

2) Calculate the initial value of the decision parameter.

$$P_0 = \frac{5}{4} - r$$

3) At each x_k position, starting at $k=0$, perform the following test -

If $P_k < 0$, the next point on the circumference is

$$(x_{k+1}, y_{k+1}) = (x_k+1, y_k) \ \&$$
$$P_{k+1} = P_k + 2x_{k+1} + 1$$

If $P_k \geq 0$, the next point on the circumference is

$$(x_{k+1}, y_{k+1}) = (x_k+1, y_k-1) \ \&$$

$$P_{k+1} = P_k + 2x_{k+1} - 2y_{k+1} + 1$$

where $2x_{k+1} = 2x_k + 2$, $2y_{k+1} = 2y_k - 1$

4) Determine ~~#~~ Symmetry points in the other seven octants.

5) Move each pixel position (x, y) on the circle path centered on (x_c, y_c) -

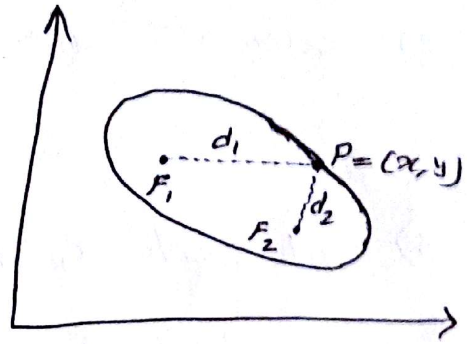
$$x = x + x_c$$
$$y = y + y_c$$

6) Repeat step 3 through 5 ~~until~~ till $x \leq y$.

* ELLIPSE :-

An ellipse is defined as the set of points such that the sum of the distances from two fixed positions (foci) is same for all points.

If the distances to the two foci from any point P on the ellipse are d_1 & d_2, then the general equation of an ellipse can be stated as -

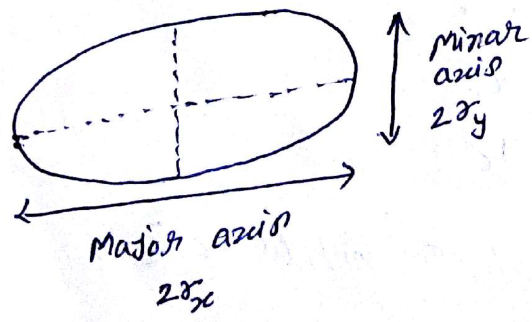


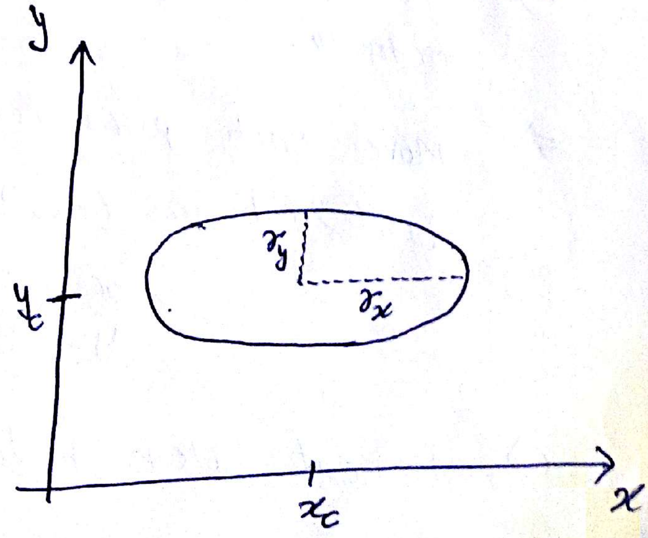
$$d_1 + d_2 = \text{constant}$$

If $F_1 = (x_1, y_1)$ & $F_2 = (x_2, y_2)$

then $$\sqrt{(x-x_1)^2 + (y-y_1)^2} + \sqrt{(x-x_2)^2 + (y-y_2)^2} = \text{constant}$$

In ellipse there are two axis: major axis & minor axis. The major axis is ~~the~~ maximum length straight line ~~or~~ from one side of ellipse to the other ~~&~~ ~~passes through one foci~~; ~~similarly~~ the minor axis is the straight line, which is ~~other foci by~~ bisecting major axis.





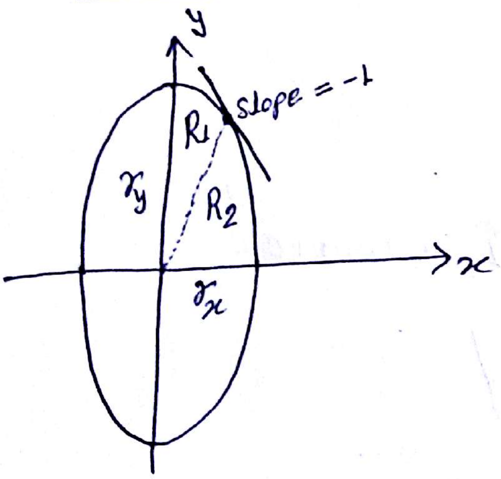
In diagram r_x is the semimajor axis and r_y is the semiminor axis. The equation of ellipse centered at (x_c, y_c) can be written as –

$$\left(\frac{x-x_c}{r_x}\right)^2 + \left(\frac{y-y_c}{r_y}\right)^2 = 1$$

✲ Ellipse MidPoint :-

Given parameter (x_c, y_c), r_x & r_y; we determine point (x, y) for an ellipse centered on the origin, and then shift the point by x_c & y_c.

For $r_x < r_y$:-



The mid point ellipse method is applied throught the first quadrant in two parts.

Region 1 (R1) :- ~~where slope~~ Here magnitude of slope is less than 1, & take unit steps in x direction.

Region 2 (R2) :- Here magnitude of slope is greater than 1, & take unit step in y direction.

Initially start at $(0, r_y)$, take unit step in x-direction untill we reach the boundary between region 1 & region 2. Then we switch to unit step in y-direction for remainder section in 1st quadrant.

At each step we need to test the slope of the curve, which is defined as –

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$$\frac{dy}{dx} = -\frac{2r_y^2 x}{2r_x^2 y}$$

At boundary $\frac{dy}{dx} = -1$

$$\Rightarrow 2r_y^2 x = 2r_x^2 y$$

Therefore, we move out of region 1, whenever

$$\boxed{2r_y^2 x \geq 2r_x^2 y}$$

Ellipse function is defined as-

Ellipse Equation

$$\boxed{\frac{x^2}{r_x^2} + \frac{y^2}{r_y^2} = 1}$$

$$f_{ellipse}(x,y) = r_y^2 x^2 + r_x^2 y^2 - r_x^2 r_y^2$$

$$f_{ellipse}(x,y) \begin{cases} < 0; & \text{if } (x,y) \text{ inside the boundary} \\ = 0; & \text{if } (x,y) \text{ is on the boundary} \\ > 0; & \text{if } (x,y) \text{ outside the boundary} \end{cases}$$

Region 1 :-

$$P1_k = f_{ellipse}\left(x_k+1,\ y_k-\frac{1}{2}\right)^2$$

$$P1_k = r_y^2(x_k+1)^2 + r_x^2\left(y_k-\frac{1}{2}\right)^2 - r_x^2 r_y^2 \quad \text{— ①}$$

~~If $P1_k < 0 \Rightarrow (x_{k+1}, y_{k+1}) =$~~

$$P1_{k+1} = f_{ellipse}\left(x_{k+1}+1,\ y_{k+1}-\frac{1}{2}\right) \quad \text{— ②}$$

② - ① $\Rightarrow$ $P1_{k+1} = P1_k + 2r_y^2(x_{k+1}) + r_y^2 + r_x^2\left[\left(y_{k+1}-\frac{1}{2}\right)^2 - \left(y_k-\frac{1}{2}\right)^2\right]$

If $P1_k < 0 \Rightarrow y_{k+1} = y_k$ & $x_{k+1} = x_k + 1$

$$P1_{k+1} = P1_k + 2r_y^2 x_{k+1} + r_y^2$$

If $P1_k > 0 \Rightarrow y_{k+1} = y_k - 1$ & $x_{k+1} = x_k + 1$

$$P1_{k+1} = P1_k + 2r_y^2 x_{k+1} + r_y^2 - 2r_x^2 y_{k+1}$$

Initially $(x_0, y_0) = (0, r_y)$

From eqⁿ ① $\Rightarrow$ $P1_0 = f_{ellipse}\left(1,\ r_y - \frac{1}{2}\right)$

$$P1_0 = r_y^2 + r_x^2\left(r_y - \frac{1}{2}\right)^2 - r_x^2 r_y^2$$

$$\boxed{P1_0 = r_y^2 - r_x^2 r_y + \frac{1}{4} r_x^2}$$

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In Region2 :-

$$P2_k = f_{ellipse}\left(x_k+\frac{1}{2},\ y_k-1\right)$$ {where (x_k, y_k) is the last point of region1}

$$= r_y^2\left(x_k+\frac{1}{2}\right)^2 + r_x^2(y_k-1)^2 - r_x^2 r_y^2 \quad —①$$

$$P2_{k+1} = f_{ellipse}\left(x_{k+1}+\frac{1}{2},\ y_{k+1}-1\right)$$

$$P2_{k+1} = r_y^2\left(x_{k+1}+\frac{1}{2}\right)^2 + r_y^2\left(y_{k+1}-1\right)^2 - r_x^2 r_y^2 \quad —②$$

② - ① $\Rightarrow$ $P2_{k+1} = P2_k - 2r_x^2(y_k-1) + r_x^2 + r_y^2\left[\left(x_{k+1}+\frac{1}{2}\right)^2 - \left(x_k+\frac{1}{2}\right)^2\right]$

If $P2_k > 0 \Rightarrow (x_{k+1}, y_{k+1}) = (x_k, y_k-1)$

$$P2_{k+1} = P2_k - 2r_x^2(y_k-1) + r_x^2$$

If $P2_k \geqslant 0 \Rightarrow (x_{k+1}, y_{k+1}) = (x_k+1, y_k-1)$

$$P2_{k+1} = P2_k - 2r_x^2(y_k-1) + r_x^2 + 2r_y^2 x_{k+1}$$

~~In region2, initial point (x_0, y_0) is the last~~

Algorithm :-

1) Input r_x, r_y & ellipse center (x_c, y_c). obtain the first point on an ellipse centered on origin as -

$$(x_0, y_0) = (0, r_y)$$

2) calculate intial value of decision parameter in region1, as -

$$P1_0 = r_y^2 - r_x^2 r_y + \frac{1}{4} r_x^2$$

3) At each x_k position in region1, perform the following test:

If $P1_k < 0 \Rightarrow (x_{k+1}, y_{k+1}) = (x_k + 1, y_k)$

$$P1_{k+1} = P1_k + 2r_y^2(x_k + 1) + r_y^2$$

otherwise $(x_{k+1}, y_{k+1}) = (x_k + 1, y_k - 1)$

$$P1_{k+1} = P1_k + 2r_y^2(x_k + 1) + r_y^2 - 2r_x^2(y_k - 1)$$

Continue until $2r_y^2 x \geq 2r_x^2 y$

4) Calculate initial decision parameter in region2, where (x_0, y_0) is the last point of region1 -

$$P2_0 = r_y^2\left(x_0 + \frac{1}{2}\right)^2 + r_x^2(y_0 - 1)^2 - r_x^2 r_y^2$$

5) At each y_k position in region2, perform the following test:

If $P2_k > 0 \Rightarrow (x_{k+1}, y_{k+1}) = (x_k, y_k - 1)$

$$P2_{k+1} = P2_k - 2r_x^2(y_k - 1) + r_x^2$$

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otherwise $(x_{k+1}, y_{k+1}) = (x_k+1, y_k-1)$

$$P2_{k+1} = P2_k - 2r_x^2(y_k-1) + r_x^2 + 2r_y^2(x_k+1)$$

continue untill I^{st} quadrant.

6) Determine the symmetry points in other three quadrants.

7) move each pixel on the elliptical path centered on (x_c, y_c) –

$$x = x + x_c$$
$$y = y + y_c$$

Q Numerical :-

Draw an ellipse using midpoint ellipse generating algorithm.

$$r_x = 8; \quad r_y = 6$$

Sol^n For Region 1:- The initial Point for the ellipse centered on the origin is $(x_0, y_0) = (0, 6)$.

The initial decision parameter is –

$$P1_0 = r_y^2 - r_x^2 r_y + \frac{1}{4} r_x^2$$

$$P1_0 = -332$$

K	$P1_K$	(x_{K+1}, y_{K+1})	$2r_y^2 x_{K+1}$	$2r_x^2 y_{K+1}$
0	-332	(1,6)	72	768
1	-224	(2,6)	144	768
2	-44	(3,6)	216	768
3	208	(4,5)	288	640
4	-108	(5,5)	360	640
5	288	(6,4)	432	512
6	244	(7,3)	504	384

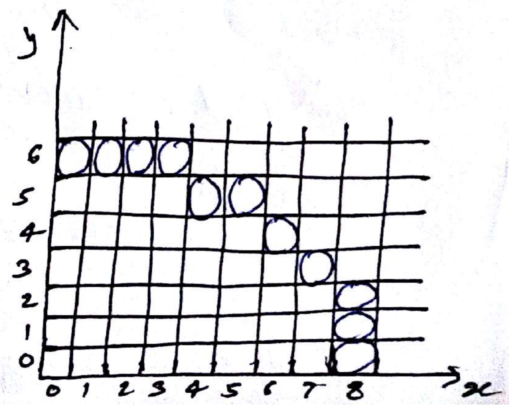
we now move out of Region 1, since $2r_y^2 x_{K+1} > 2r_x^2 y_{K+1}$

For Region 2:- The initial point is $(x_0, y_0) = (7, 3)$

The initial decision parameter is –

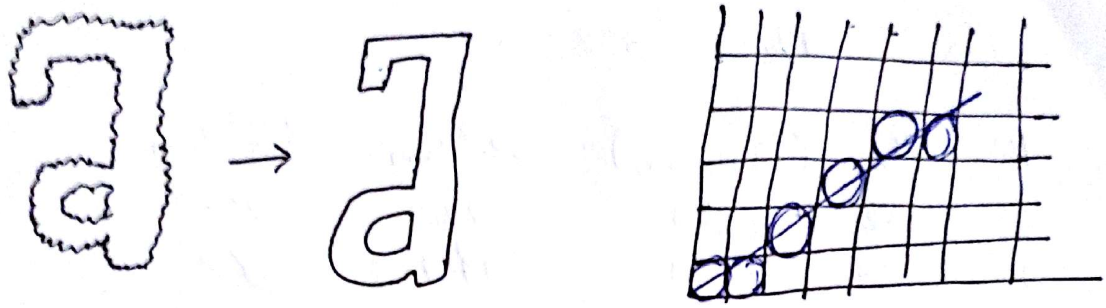
$$P2_0 = f\left(7+\frac{1}{2}, 2\right) = -151$$

K	$P2_K$	(x_{K+1}, y_{K+1})	$2r_y^2 x_{K+1}$	$2r_x^2 y_{K+1}$
0	-151	(8,2)	576	256
1	233	(8,1)	576	128
2	745	(8,0)	-	-



* Aliasing :-

In Aliasing, a line in a digital image, will often appear with jagged edges. This effect is caused by the pixel grid in the image, and it is called aliasing.



This effect is also known as staircase effect, because straight lines do not quite straight & curves do not flow smoothly but have steps & ~~looked~~ look jagged view on a monitor. The sudden jumps are called jaggies.

Main Problems in aliasing -

1) Staircase Problem
2) Unequal Intensity

* Anti-aliasing :-

Anti-aliasing is a method of fooling the eye that a jagged edge is really smooth. It is often referred in games and on graphics cards.

1) Anti-aliasing is to use changes in colour around the curved area. These slight changes make the image blend around the curve. The colour changes are on such a small scale that eyes cannot detect them.

2) By using high resolution, stair case problem removed, because more pixels become available.

~~* Priority Driven Approach :-~~

* Raster Scan Display :-

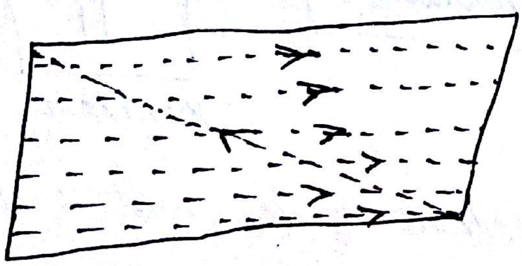
→ In a raster scan system, the electron beam is swept across the screen, one raw at a time from top to bottom.

→ As the electron beam moves across each row, the beam intensity is turned on and off to create a pattern.

→ Picture definition is stored in a memory area, called refresh buffer or frame buffer.

→ This memory area holds the set of intensity values for all the screen points; this intensity values are then retrieved from the refresh buffer and painted on the screen one row at a time.

→ The frame buffer is a digital device, while the raster scan CRT is an analog device; so conversion from digital to analog signal must take place before it is visible on the raster CRT.

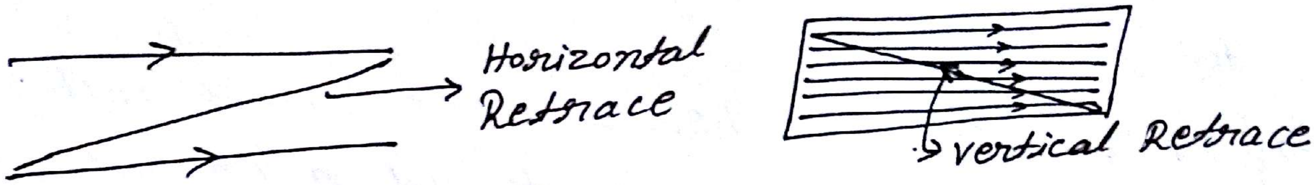


Refresh Rate :-

How many frames completed per second; it is measured in hertz (Hz).

Horizontal Retrace / Horizontal Scan Rate :-

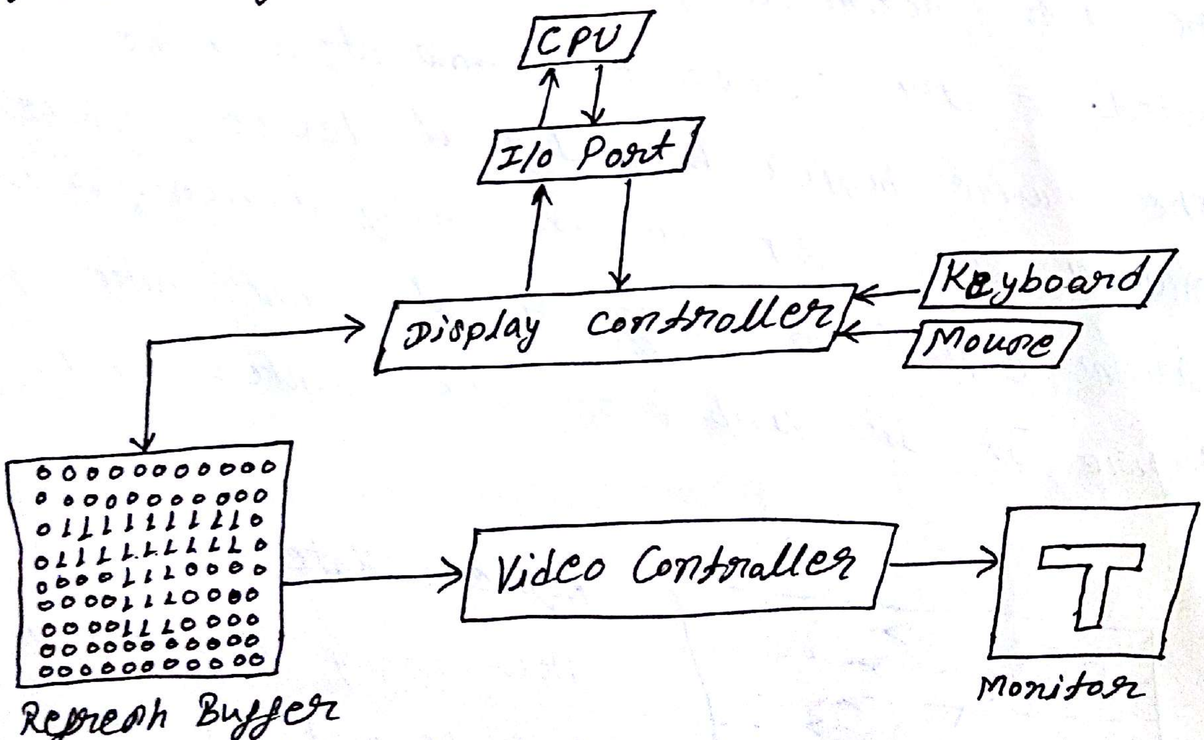
At the end of each scan line, the electron beam returns to the left side of the screen to displaying the next scan line. The return to the left of the screen, after each scan line is called horizontal retrace.



Vertical Retrace / vertical Scan Rate :-

At the end of each frame, the electron beam returns to the top left corner of the screen to begin the next frame, is called vertical retrace.

Block Diagram :-

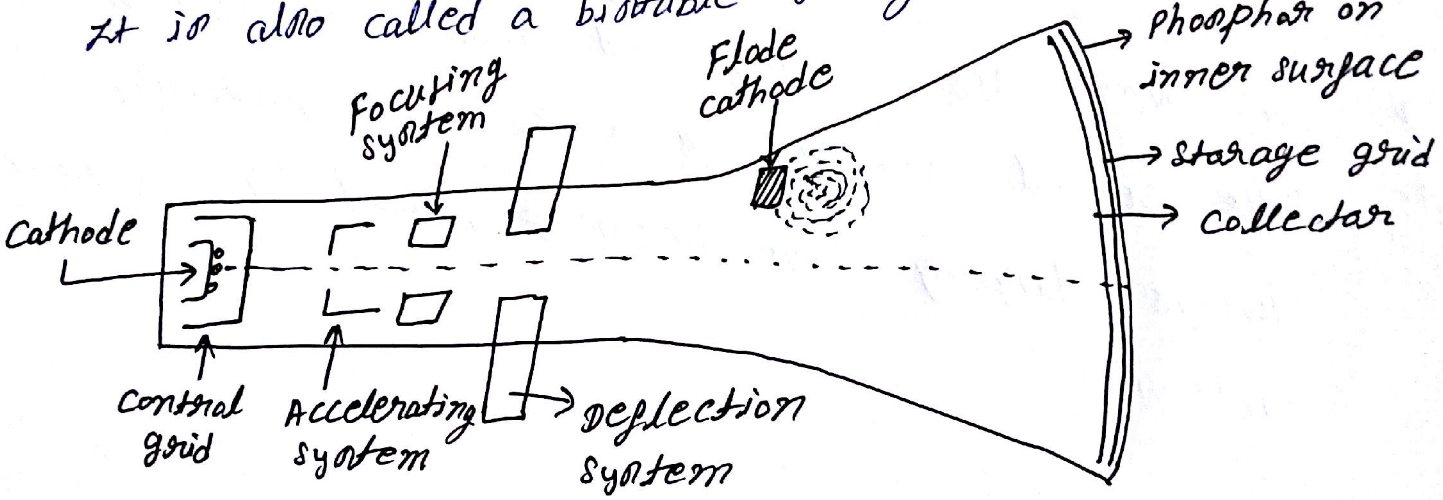


The architecture of a raster display is consist of display controller, CPU, video controller, refresh buffer, keyboard, mouse etc.

In raster display image is stored in the front of 1s and 0s in the refresh buffer. The video controller reads the refresh buffer and produces the actual image on the screen. It does this by scanning one scan line at a time, from top to bottom.

* Storage Tube Display :-

The direct view storage tube (DVST) is the simplest of the CRT displays. It is also called a bistable storage tube.



[DVST]

Basically, a DVST stores the picture information as a charge distribution just behind the phosphor coated screen.

→ Two electron guns are used in a DVST. one, the primary gun is used to store the picture pattern. second, called flood gun, maintains the picture display.

→ It is generally a CRT display technologies for line drawing. In DVST, a line or character remains visible until erased.

→ The display is erased by flooding the entire tube with a specific voltage.

Advantage

→ On comparing DVST with other CRT display ~~technique~~ techniques, it is effective because no refreshing is need and complex pictures can be displayed at very high resolutions without flicker.

Disadvantage

→ In DVST, the erasing and redrawing process can take several seconds for a complex picture; hence storage display have been replaced by raster system.

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