Practical No. 1

Title : Write a program to implement DDA algorithm for line.

Aim: Write a C / C++ program for DDA algorithm.

Theory

DDA Algorithm (Digital Differential Analyzer)

- The Vector generation algorithms which step along the line to determine the pixel which should be turned on are sometimes called Digital Differential Analyzer (DDA).

- The slope of a straight line is given as

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

The above differential equation can be used to obtain a rasterized straight line. For any given x interval Δx along a line, we can compute the corresponding y interval Δy from equation as

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

- Similarly, we can obtain the x interval Δx corres-ponding to a specified Δy as

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

- Once the intervals are known the values for next x and next y on the straight line can be obtained as follows:

$$x_{i+1} = x_i + \Delta x$$
$$= x_i + \frac{x_2 - x_1}{y_2 - y_1} \Delta y \quad \ldots (1)$$

and

$$y_{i+1} = y_i + \Delta y$$
$$= y_i + \frac{y_2 - y_1}{x_2 - x_1} \Delta x \quad \ldots (2)$$

- The equations (1) and (2) represent a recursion relation for successive values of x and y along the required line. Such a way of rasterizing a line is called Digital Differential Analyzer (DDA). For simple DDA either Δx and Δy, whichever is larger, is chosen as one raster unit, i.e.

if $|\Delta x| \geq |\Delta y|$ then

$$\Delta x = 1$$

else

$$\Delta y = 1$$

With this simplification, if $\Delta x = 1$ then.
we have

$$y_{i+1} = y_i + \frac{y_2 - y_1}{x_2 - x_1} \text{ and}$$

$$x_{i+1} = x_i + 1$$

If $\Delta y = 1$ then
we have $y_{i+1} = y_i + 1$ and

$$x_{i+1} = x_i + \frac{x_2 - x_1}{y_2 - y_1}$$

Let us see the vector generation / DDA routine for rasterizing a line.

- Vector Generation / DDA line Algorithm

1. Read the line end points (x_1, y_1) and (x_2, y_2) such that, they are not equal.
   (if equal then plot that point and exit)

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

3. if $(\Delta x \geq \Delta y)$ then
   length $= \Delta x$
   else
   length $= \Delta y$
   end if

4. $\Delta x = (x_2 - x_1) / \text{length}$
$\Delta y = (y_2 - y_1) / \text{length}$

[This makes either Δx or Δy equal to 1 because length is either $|x_2 - x_1|$ or $|y_2 - y_1|$. Therefore, the incremental value for either x or y is one].

5. $x = x_1 + 0.5 * \text{Sign}(\Delta x)$
$y = y_1 + 0.5 * \text{Sign}(\Delta y)$

Here, Sign function makes the algorithm work in all quadrant. It returns $-1, 0, 1$ depending on whether the argument is < 0, $= 0$, > 0 respectively. The factor 0.5 makes it possible to round the values in the integer function rather than truncating them.

plot (Integer (x), Integer (y)).

6. $i = 1$
[Begins the loop, in this loop points are plotted]

```
While (i ≤ length)
{
    x = x + Δx
    y = y + Δy
    plot (Integer (x), Integer (y))
    i = i + 1
}
```

7. Stop

Example - Consider the line from (0,0) to (4,6). Use the simple DDA algorithm to rasterize this line.

Step 1 : The line endpoints are

$x_1 = 0 \qquad x_2 = 4$

$y_1 = 0 \qquad y_2 = 6$

Step 2 : $\Delta x = |x_2 - x_1| \qquad \Delta y = |y_2 - y_1|$

$= |4 - 0| \qquad = |6 - 0|$

$\Delta x = 4 \qquad \Delta y = 6$

Step 3 : Here, $\Delta x = 4$ & $\Delta y = 6$

$\Delta y > \Delta x$

So, length $= \Delta y$

$= 6$

Step 4 :

$\Delta x = (x_2 - x_1) / \text{length}$

$= (4-0)/6$

$= 4/6$

$\Delta x = 0.66$

$\Delta y = (y_2 - y_1) / \text{length}$

$= (6-0)/6$

$= 6/6$

$\Delta y = 1$

Page No.:

Step 5: $x = x_1 + 0.5 * \text{Sign}(\Delta x)$
$= 0 + 0.5 * (1)$
$= 0.5$

$y = y_1 + 0.5 * \text{Sign}(\Delta y)$
$= 0 + 0.5 * (1)$
$= 0.5$

plot (0, 0)

Step 6: $i = 1$

1) $i = 1$
$1 \leq 6$
$x = x + \Delta x$
$= 0.5 + 0.66$
$x = 1.16$

$y = y + \Delta y$
$= 0.5 + 1$
$= 1.5$

2) $i = 2$
$x = x + \Delta x$
$= 1.16 + 0.66$
$= 1.82$
$y = y + \Delta y$
$= 1.5 + 1$
$= 2.5$

3) $i = 3$
$x = 1.82 + 0.66$
$= 2.48$
$y = 2.5 + 1$
$= 3.5$

4) $i = 4$
$x = 2.48 + 0.66$
$= 3.14$
$y = 3.5 + 1$
$= 4.5$

5) $i = 5$

$x = 3.14 + 0.66$
$= 3.80$

$y = 4.5 + 1$
$= 5.5$

6) $i = 6$

$x = 3.80 + 0.66$
$= 4.46$

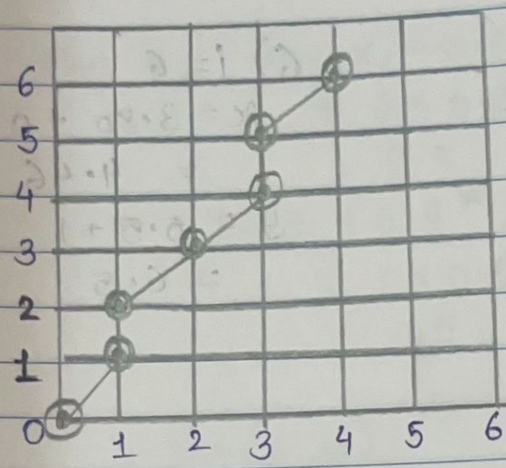
$y = 5.5 + 1$
$= 6.5$

Now, $i = i + 1$
$i = 7$
$7 \leq$ length i.e $7 \leq 6$ No...

Step 7: Stop

i	x	y	Plot
0	0.50	0.50	(0,0)
1	1.16	1.5	(1,1)
2	1.82	2.5	(1,2)
3	2.48	3.5	(2,3)
4	3.14	4.5	(3,4)
5	3.80	5.5	(3,5)
6	4.46	6.5	(4,6)

RSCOE Page No. :



Conclusion

Hence, I've leaunt about Digital Differential Analyzer (DDA) and have also implemented it using C/C++ program.