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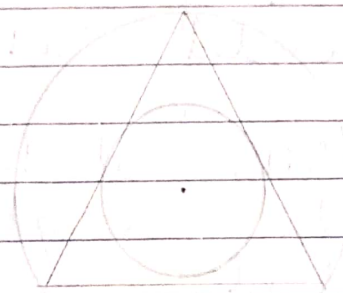
Assignment-2. - A2

Title : Circle Drawing Algorithms :

Problem Statement : Write a C++ program to draw inscribed & circumscribed circles in the triangle as shown in example. Use Bresenham circle drawing algorithm for outer circle and DDA circle for inner circle. Use any line drawing algorithm for drawing triangle.



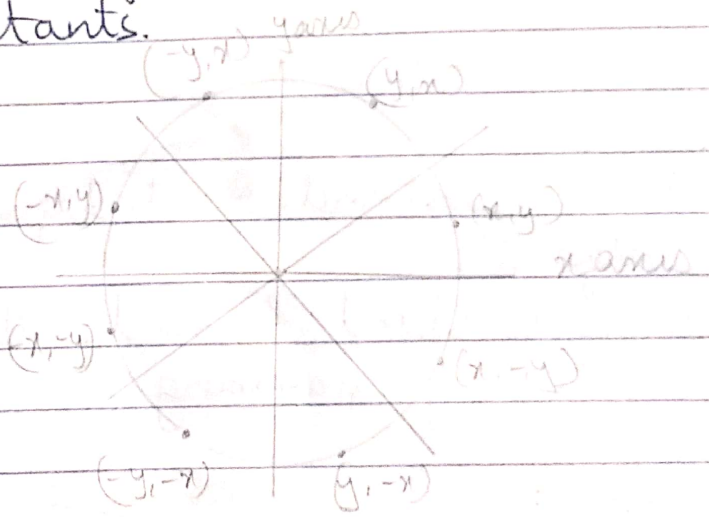
Objectives :
- To understand & study the circle drawing algorithms.
- To understand & study the concepts of object oriented programming

Outcomes :
- To study & use the different manipulation facilities in at creator using C++.
- To draw a circle with circle drawing algorithms.

Theory:

Bresenham's Circle Drawing Algorithm :-

- Bresenham's Circle Drawing Algorithm selects the nearest pixel position to compute the arc.
- The unique part of this algorithm is that it uses only integer arithmetic which makes it faster.
- This circle drawing algorithm uses 8-way symmetric property of circle, by which a circle is divided into 8 octants each of 45 degrees.
- This algorithm calculates the location of pixel in the first octant at 45° & extends it to 7 octants.



Algorithm :

1] Read the center point of circle (x_c, y_c) & radius r
2] Set the initial values as: $x=0$ $y=r$
3] Calculate the initial decision parameter
$d = 3-(2*r)$
4] Call a draw circle (int x_c, int y_c, int x, int y) function to display point.
5] If $d<0$ then

set $d = d + (4 * x) + 6$

Else

Set $d = d + 4 * (x - 4) + 10$

Decrement y by 1

6] Increment x

7] Repeat step 4 to 6 until $x \leq y$

8] Exit

The draw circle function will plot the points for 8 different octet and will construct the circle. The 8 plots are:-

$(x_c + x, y_c + y)$; $(x_c + x, y_c - y)$; $(x_c - x, y_c + y)$;
$(x_c - x, y_c - y)$; $(x_c + y, y_c + x)$; $(x_c + y, y_c - x)$;
$(x_c - y, y_c + x)$; $(x_c - y, y_c - x)$

Advantages:

The entire algorithm is based on simple equation of circle $x^2 + y^2 = R^2$

It is easy to implement as well as faster algorithm.

Disadvantages:

- Accuracy of point generation is less.
- Suffers when used with complex and high graphical images.

DDA Algorithm derivation

$x^2 + y^2 = r^2$

$2x + 2y\frac{dy}{dx} = 0$

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

$2x\,dx = -2y\,dy$

$\frac{x}{y} = \frac{-dy}{dx}$

$\boxed{\frac{dy}{dx} = -\frac{x}{y}}$

DDA Circle Drawing Algorithm.

- This method uses incremental method to plot each point.
- DDA can be used to draw a circle by defining circle as a differential equation

$$\frac{dy}{dx} = \frac{-x}{y}$$

The circle is constructed by using incremental x value $\Delta x = \epsilon y$ and incremental y value $\Delta y = -\epsilon x$, where ϵ is calculated from the radius of circle as $\epsilon = 2^{-n}$

Algorithm:

1] Read center of circle (x_c, y_c) & radius r.
2] Initialize the values as $x_1 = r$ $y_1 = 0$
   start_x = x_1 , start_y = y_1
3] Calculate value of ε as
   $\varepsilon = 1.0/r$.
4) do
   {
      initialize / set $x_2 = x_1 + \epsilon * y_1$
      $y_2 = y_1 - \epsilon * x_2$
      setpixel $(x_c + x_2, y_c - y_2$, color)
      set $x_1 = x_2$
      $y_1 = y_2$
   while $((y_1 - start\_y) < \varepsilon$ or $(start\_x - x_1) > \varepsilon)$
5] Exit.

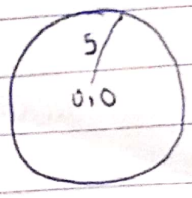
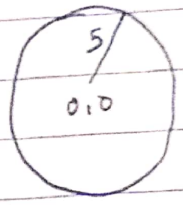
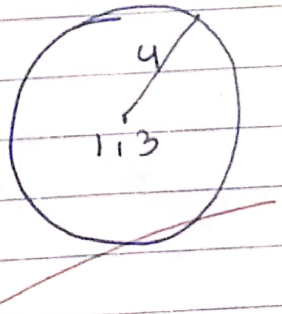
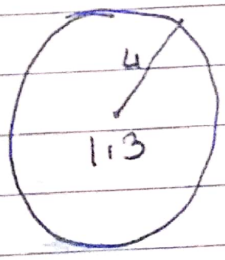
Advantages

- Plots the point of circle in incremental method by defining the circle as differential equation.

Disadvantages :-

- Slow than bresenham's algorithm as it uses floating point calculations.
- DDA algorithm can draw circles and curves but that are not as accurate as bresenhams algorithm.

Test Cases :

	Expected	Actual	Result
1) $x_c = 0$ $y_c = 0$ $r = 5$ DDA algorithm			Pass
2) $x_c = 1$ $y_c = 3$ $r = 4$			Pass

Conclusion: Using DDA and Bresenhams algorithm we drew the following figure.