INSTITUTE OF ENGINEERING

ADVANCED COLLEGE OF ENGINEERING AND MANAGEMENT
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(AFFILIATED TO TRIBHUVAN UNIVERSITY)

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OF ENGINEERING & MANAGEMENT

LAB REPORT

SUBJECT : Computer Graphics
LAB NO : 4

SUBMITTED BY:

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DATE :

SUBMITTED TO:

Department of Computer and Electronics

Title: Mid-Point Circle Algorithm

Objectives
- To learn about mid-point circle algorithm and implement it using C programming

Theory
We can define a circle function with centre (0,0) and radius as

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

Any point (x,y) on boundary of circle with radius r satisfies equation $f_{circle}(x,y)=0$

If point is inside circle, $f(x,y)<0$ else $f(x,y)>0$ i.e.

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

Assume (x_k, y_k) is plotted, we next need to determine whether pixel at position (x_k+1, y_k) or (x_k+1, y_k-1) is closer to the circle.

Now, decision parameter is,

$$P_k = f_{circle}(x_k+1,\ y_k-1/2) \cdots (i)$$

For successive decision parameter,

$$P_{k+1} = f_{circle}(x_{k+1}+1,\ y_{k+1}-1/2) \cdots (ii)$$

Subtracting (i) from (ii)

$$P_{k+1} - P_k = f_{circle}(x_{k+1}+1, y_{k+1}-1/2) - f_{circle}(x_k+1, y_k-1/2)$$

$$= [(x_{k+1}+1)^2 + (y_{k+1}-1/2)^2 - r^2] - [(x_k+1)^2 + (y_k-1/2)^2 - r^2]$$

$$= x_{k+1}^2 + 2x_{k+1} + 1 + y_{k+1}^2 - y_{k+1} + 1/4 - [x_k^2 + 2x_k + 1 + y_k^2 - y_k + 1/4]$$

$$= 2x_{k+1} + 1 + y_{k+1}^2 - y_{k+1} - y_k^2 + y_k$$

$$= 2x_{k+1} + 1 + y_{k+1}^2 - y_k^2 - (y_{k+1} - y_k) \cdots (iii)$$

If $P_k<0$

$x_{k+1} = x_k+1$

$y_{k+1} = y_k$

$\therefore P_{k+1} = P_k + 2x_{k+1} + 1$

$P_K \geq 0$

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

$y_{K+1} = y_K - 1$

$P_{K+1} = P_K + 2x_{K+1} + 1 + (y_K - 1)^2 - y_K^2 + 1$

$= P_K + 2x_{K+1} + 1 + y_K^2 - 2y_K + 1 - y_K^2 + 1$

$= P_K + 2x_{K+1} + 1 - 2(y_K - 1)$

$= P_K + 2x_{K+1} - 2y_{K+1} + 1$

Now, initial decision parameter is

$P_0 = f_{circle}(x_K + 1, y_K - 1/2)$

$= f_{circle}(1, r - 1/2)$

$= 1^2 + (r - 1/2)^2 - r^2$

$= 5/4 - r$

$= 1 - r$

<u>Algorithm</u>

1. Input centre (x_K, y_K) and radius r and set $(x_0, y_0) = (0, r)$
2. Calculate initial decision parameter as

   $P_0 = 5/4 - r \approx 1 - r$
3. At each x_K position, starting at $k=0$, perform following test:

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

   & $P_{K+1} = P_K + 2x_{K+1} + 1$

   else, next point is $(x_K + 1, y_K - 1)$

   $P_{K+1} = P_K + 2x_{K+1} - 2y_{K+1} + 1$

   where, $2x_{K+1} = 2x_K + 2$ & $2y_{K+1} = 2y_K - 2$
4. Determine symmetry points in other seven octants.
5. Move each calculated pixel position (x, y) onto the circular path centered on (x_K, y_K) and plot the co-ordinate values.

   $x = x + x_c$

   $y = y + y_c$
6. Repeat step 3 through 5 until $x \geq y$.