BSc Computer Science
CS1541 Computer Graphics

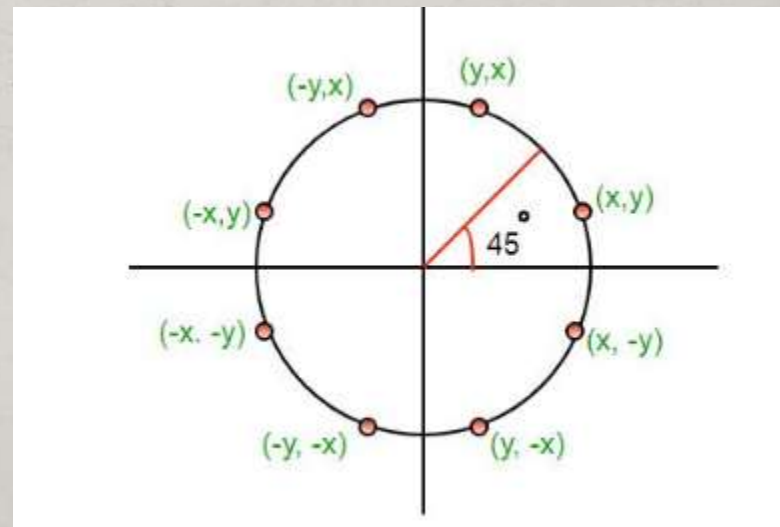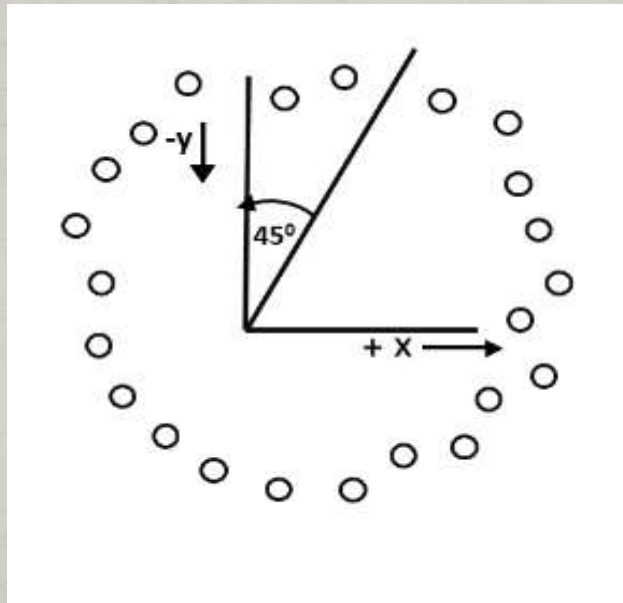## MODULE I
MIDPOINT CIRCLE DRAWING METHOD

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Overview

Points are generated from 90° to 45°, moves will be made only in the +x & -y directions.
The best approximation of the true circle will be described by those pixels in the raster that falls the least distance from the true circle.

Basic Principle

❑ For any given pixel (x, y), the next pixel to be plotted is either **(x, y+1)** or **(x-1, y+1)**. This can be decided by following the steps below.

1. Find the mid-point **p** of the two possible pixels i.e (x-0.5, y+1)
2. If **p** lies inside or on the circle perimeter, we plot the pixel (x, y+1), otherwise if it's outside we plot the pixel (x-1, y+1)
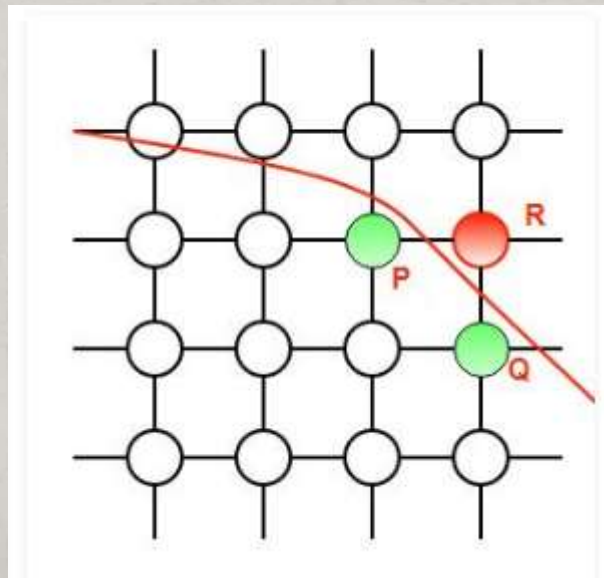
The Method

consider the coordinates of the point halfway between pixel T and pixel S
This is called midpoint $(x_{i+1}, y_i - 1/2)$ and we use it to define a decision parameter:
$P_i = f(x_{i+1}, y_i - 1/2) = (x_{i+1})^2 + (y_i - 1/2)^2 - r^2$ ....equation 2
If P_i is -ve $\Longrightarrow$ midpoint is inside the circle and we choose pixel T
If P_i is+ve $\Longrightarrow$ midpoint is outside the circle (or on the circle)and we choose pixel S.

The Method

The decision parameter for the next step is:

$P_{i+1}=(x_{i+1}+1)^2+(y_{i+1}- \quad)^2- r^2$............equation 3

Since $x_{i+1}=x_{i+1}$, we have

$$P_{i+1} - P_i = ((x_i + 1) + 1)^2 - (x_i + 1)^2 + (y_{i+1} - \tfrac{1}{2})^2 - (y_i - \tfrac{1}{2})^2$$

$$= x_i^2 + 4 + 4x_i - x_i^2 + 1 - 2x_i + y_{i+1}^2 + \tfrac{1}{4} - y_{i+1} - y_i^2 - \tfrac{1}{4} - y_i$$

$$= 2(xi+1) + 1 + (y_{i+1}^2 - y_i^2) - (y_{i+1} - y_i)$$

$$P_{i+1} = P_i + 2(x_i + 1) + 1 + (y_{i+1}^2 - y_i^2) - (y_{i+1} - y_i) \ldots\ldots\ldots\ldots\ldots\text{equation 4}$$

Algorithm

Algorithm MidpointCircle(X_0,Y_0,R)

[Draw a circle with center (X0,Y0) and radius R]

Step 1: [Initialize]

          $X \leftarrow 0$ $Y \leftarrow R$ $P \leftarrow 1-R$

Step 2: [Plot 8 symmetric points at each step]

       Repeat while X<=Y

             Plot(X_0+ X, Y_0+ Y), Plot(X_0+ Y, Y_0+ X),

             Plot(X_0- Y, Y_0+ X), Plot(X_0 – X, Y_0+ Y),

             Plot(X_0 - X, Y_0 - Y), Plot(X_0 - Y, Y_0 - X),

             Plot(X_0 + Y, Y_0 - X), Plot(X_0 + X, Y_0 - Y)

             $X \leftarrow X+1$

             If (P < 0)

                  $P \leftarrow P+ 2* X +3$

           else

                  $Y \leftarrow Y- 1$

                  $P \leftarrow P+ 2*(X-Y)+5$

           Endif

         End Repeat

Step 3 : [Finished]

        Return

Example

Origin $(X_0, Y_0) \rightarrow (50,50)$ and Radius $R \rightarrow 15$

Step	X	Y	P	Output
1	0	15	-27	(50, 65), (65,50), (35,50), (50,65), (50,35), (35,50), (65,50), (50, 35)
2	1	15	-22	
3	2	15	-15	
4	3	15	-6	
5	4	15	5	
6	5	14	-8	
7	6	14	7	
8	7	13	2	
9	8	12	-3	
10	9	12	18	
11	10	11	21	

Thank You