LAB 4: IMPLEMENTATION OF MIDPOINT CIRCLE DRAWING ALGORITHM

Objectives:

1. To understand the concept of circle generation in raster graphics.
2. To study the working principle of the Midpoint Circle Drawing Algorithm.
3. To implement the Midpoint Circle Drawing Algorithm using integer arithmetic.
4. To utilize symmetry properties for efficient circle drawing.
5. To analyze the efficiency of the algorithm in computer graphics applications.

Software(S) Required

Python 3, matplotlib

Theory

The Midpoint Circle Drawing Algorithm is a fundamental computer graphics algorithm used to draw a circle on a pixel-based display efficiently. Unlike traditional methods that rely on floating-point calculations, this algorithm uses only integer arithmetic, making it faster and more suitable for real-time graphics systems.

A circle with center at the origin is mathematically represented by the equation:

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

where rr is the radius of the circle. The algorithm works by selecting the pixel closest to the actual circle path using a decision parameter.

The algorithm starts plotting from the point (0,r) and continues towards (r,0)in the first octant. At each step, the midpoint between two candidate pixels is evaluated. If the midpoint lies inside the circle, the pixel in the east direction is chosen; otherwise, the pixel in the south-east direction is selected. The decision parameter is updated at every iteration.

An important advantage of the Midpoint Circle Drawing Algorithm is its **eight-way symmetry**. Due to the symmetrical nature of a circle, the calculated points in one octant can be mirrored to the remaining seven octants, reducing the total number of computations.

Mid-Point Circle Algorithm

Step1: Start

Step2: Declare variables (x_0, y_0, p, r, x_c, y_c)

Step3: Read the values r, x_c, y_c.

Step 4: Initialize $x_0=0$, $y_0=r$

Step 5: Calculate initial decision parameter ($p_0=\frac{5}{4}$ -r)

Step 6: Repeat until $y \geq x$

a. If $P_k<0$, $x_{k+1}=x_k+1$ (increase with +1)

$y_{K+1}=y_k$ (No change)

$P_{k+1}=P_k+2x_k+1+1$

Else, if $P_k \geq 0$,

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

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

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

b. Determine the symmetry in other 7 octants

c. $x=x+x_c$

$y=y+y_c$

d. Plot(x, y)

Step 7: Stop