COSC 4370 - Homework 1

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1 Problem

The assignment requires the rasterization of an ellipse defined by the equation:

(x/16)^2 + (y/16)^2 = 30^2 where x <= 0.

The ellipse is to be rasterized on a 200x200 canvas. The semi-major axis a is 480, and the semi-major axis b is 750. However, to fit the ellipse within the 200x200 canvas, the axes are scaled down by a factor of 10, resulting in a = 48 and b = 75. The goal is to implement an algorithm to rasterize the ellipse efficiently, ensuring that there are no gaps in the rendered image.

2 Method

The Midpoint Ellipse Algorithm was used to rasterize the ellipse. This algorithm divides the ellipse into two regions based on the slope of the tangent:

Region 1: Where the slope of the tangent is less than or equal to 1.

Region 2: Where the slope of the tangent is greater than 1.

The algorithm uses incremental calculations to determine the next pixel to plot, minimizing the use of expensive operations like multiplication. Symmetry is exploited to plot pixels in all 4 quadrants of the ellipse.

Two key functions were implemented:

1. plotEllipsePoints: Plots a pixel and its symmetric counterparts in the specified quadrants.

2. rasterizeEllipse: Implements the Midpoint Ellipse Algorithm to rasterize the ellipse.

3 Implementation

In the main function of the program, using the bmpNew function from the BMP header file the program will create a 200x200 canvas using a BMP image. Then using the bmpNew.fill_region function it will color the entire 200x200 canvas black. Next the program rasterizes the ellipse using 2 different functions, the plotEllipsePoints function to record the points of the ellipse and plot a pixel and its symmetric counterparts and the rasterizeEllipse function to create the ellipse itself using the Midpoint Ellipse Algorithm.

3.1 plotEllipsePoints Function

This function takes the center of the ellipse (cx, cy), the current pixel coordinates (x, y), and the color values (R, G, B, A) as input. It then plots the pixel and its symmetric counterparts in the specified quadrants using the set_pixel method of the BMP class. For this problem, only quadrants 2 and 3 are plotted (where x <= 0).

3.2 rasterizeEllipse Function

This function implements the Midpoint Ellipse Algorithm. It calculates the decision parameter p to determine the next pixel to plot. It divides the ellipse into 2 regions and uses incremental calculations to determine the next pixel to plot. The algorithm is divided into 2 regions:

Region 1: Moves in the x-direction and calculates the decision parameter p. If p < 0, the algorithm moves horizontally. If p > 0, it moves diagonally (decreasing y).

Region 2: Moves in the y-direction and calculates the decision parameter p. If p > 0, the algorithm moves vertically. If p < 0, it moves diagonally (increasing x).

4 Results

The output of the program is a BMP file (output.bmp) that contains the rasterized ellipse. The ellipse is centered at (100, 100) on a 200x200 canvas. The ellipse is drawn white on a black background, and only the left half of the ellipse (x <= 0, quadrants 2 and 3) is drawn. When viewed through an image viewer, the output shows a smooth, continuous half ellipse that fits perfectly within the 200x200 canvas.