

PROBLEM STATEMENT

To implement the Cohen-Sutherland and Liang-Barsky Line Clipping Algorithms in C using OpenGL, and to draw and clip a line segment against a defined clipping window. The program will also draw the coordinate axes for better visualization.

THEORY

Line clipping algorithms are used in computer graphics to determine which portions of a line lie inside a specified rectangular clipping window. The Cohen-Sutherland and Liang-Barsky algorithms are two such methods, each with its own approach to line clipping.

Cohen-Sutherland Algorithm

The Cohen-Sutherland Algorithm divides the 2D space into nine regions, using a 4-bit outcode for each endpoint of the line. The outcode indicates the location of the point relative to the clipping window. Depending on the outcodes, the algorithm either accepts, rejects, or clips the line.

Liang-Barsky Algorithm

The Liang-Barsky Algorithm uses parametric line equations and inequalities to find intersections of a line with the clipping window edges. This method is more efficient than Cohen-Sutherland, as it reduces the number of comparisons needed.

ALGORITHMS

Cohen-Sutherland Algorithm

1. Initialize the outcodes for both endpoints of the line.
2. Use bitwise operations to determine trivial acceptance or rejection.
3. If neither, find the intersection point and update the outcode.
4. Repeat until the line is either accepted or rejected.

Liang-Barsky Algorithm

1. Calculate the differences dx and dy for the line segment.
2. For each boundary, compute the parametric values of intersections.
3. Adjust the parameter range $[u1, u2]$ based on the intersections.
4. If the final range is valid, calculate the clipped line segment.

SAMPLE I/O

Input:

Line endpoints: (10, 10) and (500, 500)

Clipping window: $x_{min} = 50$, $y_{min} = 50$, $x_{max} = 400$, $y_{max} = 400$

Output: The line segment is clipped according to the specified clipping window and displayed in a window with coordinate axes.

DISCUSSIONS

- **Cohen-Sutherland Algorithm:**

- **Advantages:** Simple to implement, works well with trivial accept/reject cases.
- **Disadvantages:** May require multiple iterations to clip complex cases.

- **Liang-Barsky Algorithm:**

- **Advantages:** More efficient with fewer calculations, particularly for complex cases.
- **Disadvantages:** Slightly more complex to implement compared to Cohen-Sutherland.

- **Applications:** Both algorithms are used in computer graphics for rendering scenes, CAD software, and game development.

CONCLUSION

Both the Cohen-Sutherland and Liang-Barsky Line Clipping Algorithms are fundamental in computer graphics for handling line clipping against rectangular windows. Each algorithm has its strengths and trade-offs, making them suitable for different scenarios. Implementing these algorithms using OpenGL provides a visual understanding of their operations and effectiveness.