Clipping Algorithms

Clipping algorithms are designed to efficiently identify the portions of a scene (in viewing coordinates) that lie inside a given viewport. They are useful because they

- excludes unwanted graphics from the screen;
- improves efficiency, as the computation dedicated to objects that appear off screen can be significantly reduced;
- can be used in other ways (modelling of rectangular aperatures, for example).

Two possible ways to apply clipping in the viewport transformation:

1. Apply clipping in the world coordinate system: ignore objects (e.g., vertices, line segments, and polygons) that lie outside of the window.
2. Apply clipping in the device coordinate system:ignore objects that lie outside of the viewport.

Point Clipping

Let W denote a clip window with coordinates $(x_{\text{min}}, y_{\text{min}})$, $(x_{\text{min}}, y_{\text{max}})$, $(x_{\text{max}}, y_{\text{min}})$, $(x_{\text{max}}, y_{\text{max}})$, then a vertex (x, y) is displayed only if *all* four of the following "point clipping" inequalities are satisfied:

$$x_{\text{min}} \leq x \leq x_{\text{max}}, \quad \text{and,} \quad y_{\text{min}} \leq y \leq y_{\text{max}}.$$

- Can be applied in viewing or device coordinates.
- Very simple and efficient!
- Only works for vertices.

Line Clipping

In computer graphics, a the term “line” usually refers to a line segment.

Basic principles (assuming the clip window W is convex):

- If both endpoints of a line segment fall within W, then display the line segment.
- If both endpoints of a line segment fall outside of W because they violate the same point clipping inequality, then do not display the line segment.
- If one endpoint falls within W and another falls outside, then part of the line segment is displayed.
- If both endpoints fall outside W, but do not violate a common point clipping inequality, then part of the line may be visible.

Intersection Test

Let (x_1, y_1) and (x_2, y_2) denote two endpoints of a given line segment S. Then the line segment can be described parametrically as

$$\begin{aligned} x &= x_1 + u(x_2 - x_1) \\ y &= y_1 + u(y_2 - y_1) \end{aligned}$$

where u varies over the interval $0 \leq u \leq 1$.

How can we use the above to determine if S intersects the boundary of W?

Example