Line and Polygon Clipping

Chapter 7

Clipping

Line and Polygon Clipping (2D)

Problem:
Given a 2D line/polygon and a window, clip the line/polygon to their regions that are inside the window.

- Objectives
  - Efficiency
  - (Parallelization)
- Two approaches
  - Explicit (continuous setting)
  - Implicit (discrete setting) - part of scan conversion

Rendering Pipeline

- Geometric Content
- Model/View Transform
- Lighting
- Perspective Transform
- Clipping
- Scan Conversion
- Texturing
- Depth Test
- Blending
- Frame-buffer

Explicit Solution: Line Segments

- Intersection of convex regions is convex
- Why?
  - L & D are convex - intersection is convex
    - single connected segment of L
- Clipping uses intersections of L with four boundary segments of window D

Basic Method

- Works, but inefficient for lines OUTSIDE D
- Four intersection tests
- Note: need special care for vertices ON window edges

Convexity

Set $C \subseteq \mathbb{R}^d$ is **convex** if for any two points $p, q \in C$ and any $\alpha \in [0,1]$, $\alpha p + (1-\alpha)q \in C$

2D Projection of convex 3D shape is convex

Discard geometry outside viewport window

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Cohen-Sutherland Algorithm (cont’d)

C-S-Clip( P1, P2, P3, P4 )

( assume zoff < zon )

P1 = (x1, y1, z1) P2 = (x2, y2, z2) P3 = (x3, y3, z3) P4 = (x4, y4, z4)

if ( zoff < zon ) then return
    if ( (zoff = zon) and (zoff = 0) ) then draw (P1, P2)
    else if (OutsideWindow( P1 ) ) then
        begin
        End if
    end

begin
    if ( OutsideWindow( Window ) ) then
        return
    end

begin

    if ( OutsideWindow( Window ) ) then
        return
    end

    if ( zoff < zon ) then return

    if ( (zoff = zon) and (zoff = 0) ) then draw (P1, P2)

    if ( (zoff < zon) or (zoff > zon) ) then return

    end

end

Determine portion of line inside axis-aligned box (viewing frustum in NDC)
Simple extension of 2D algorithms
After projection transform
    clipping volume always the same
        xmin=ymin=zmin= -1, xmax=ymax=zmax= 1
    boundary lines become boundary planes
        but bit-codes still work the same way

3D clipping

Triangle Clipping

How does intersection of rectangle & triangle looks like?
    How many sides?

How to expand clipping to triangles?
    Hint: it is convex
    Will sketch on the board...

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