جامعة الشام الخاصة

ASPU
2011

Al-sham Private University

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Al-Sham Private University

Informatics Engineering

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Visible Surface Detection

Contents

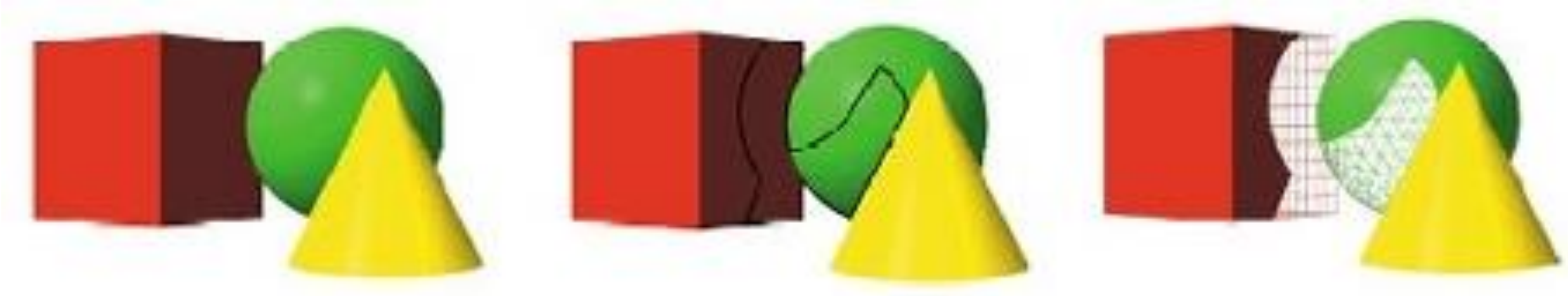
Today we will start to take a look at visible surface detection techniques:

- Why surface detection?
- Back face detection
- Depth-buffer method
- A-buffer method
- Scan-line method

Why?

We must determine what is visible within a scene from a chosen viewing position

For 3D worlds this is known as **visible surface detection** or **hidden surface elimination**



Two Main Approaches

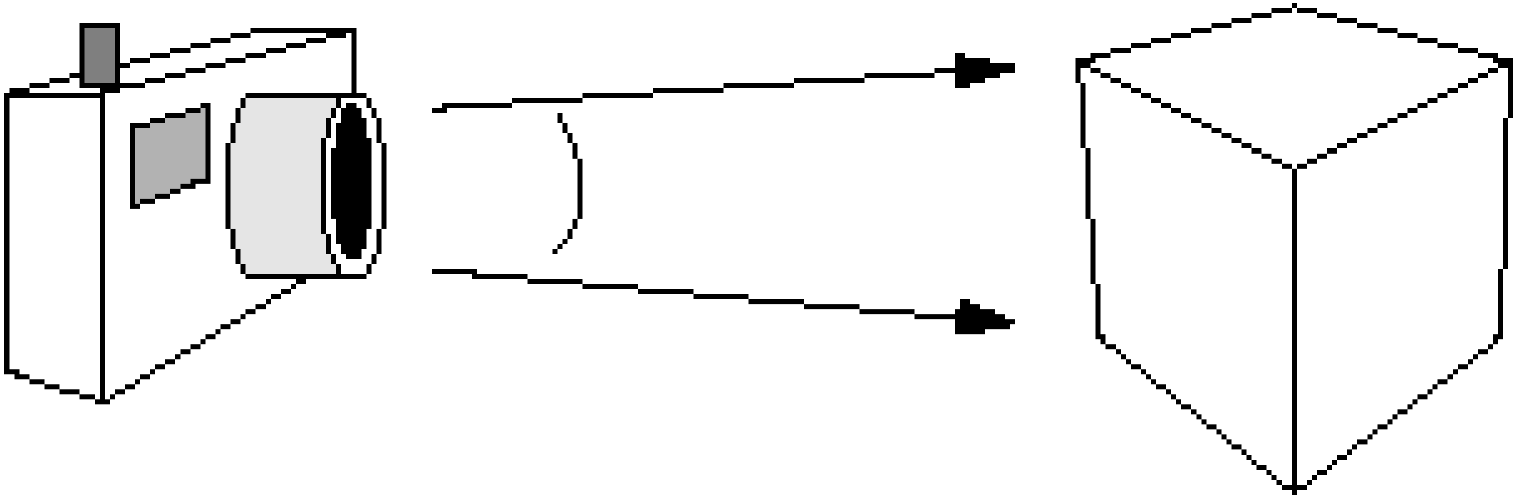
Visible surface detection algorithms are broadly classified as:

- **Object Space Methods:** Compares objects and parts of objects to each other within the scene definition to determine which surfaces are visible
- **Image Space Methods:** Visibility is decided point-by-point at each pixel position on the projection plane

Image space methods are by far the more common

Back-Face Detection

The simplest thing we can do is find the faces on the backs of polyhedra and discard them



Back-Face Detection (cont…)

We know from before that a point (x, y, z) is behind a polygon surface if:

$$Ax + By + Cz + D < 0$$

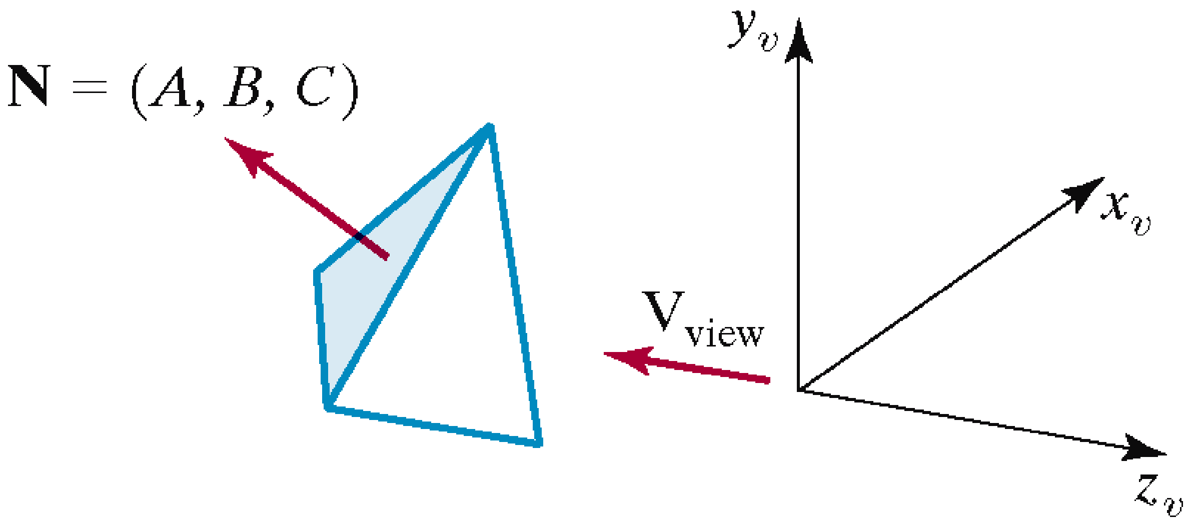
where A, B, C & D are the plane parameters for the surface

This can actually be made even easier if we organise things to suit ourselves

Back-Face Detection (cont…)

Ensure we have a right handed system with the viewing direction along the negative *z*-axis

Now we can simply say that if the *z* component of the polygon's normal is less than zero the surface cannot be seen

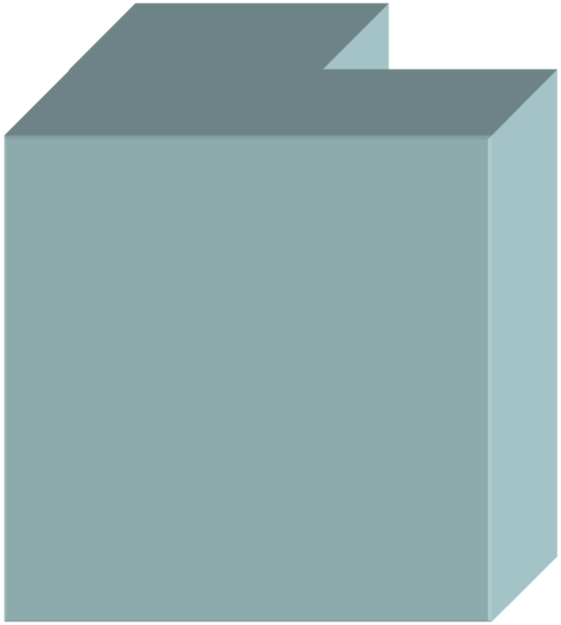


Back-Face Detection (cont…)

In general back-face detection can be expected to eliminate about half of the polygon surfaces in a scene from further visibility tests

More complicated surfaces though scupper us!

We need better techniques to handle these kind of situations



Depth-Buffer Method (Z-buffer)

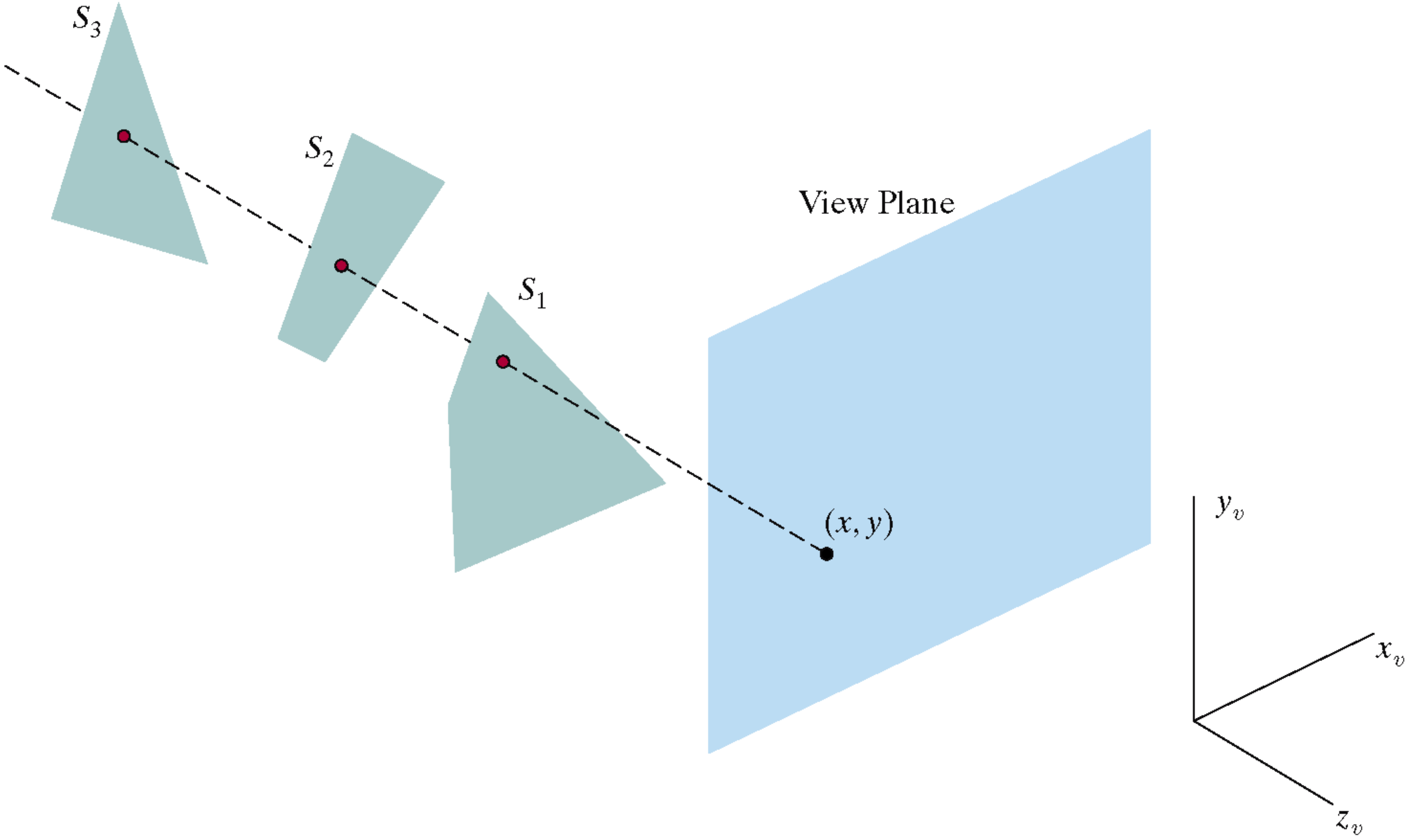
Compares surface depth values throughout a scene for each pixel position on the projection plane

Usually applied to scenes only containing polygons

As depth values can be computed easily, this tends to be very fast

Also often called the z-buffer method

Depth-Buffer Method (cont…)



Depth-Buffer Algorithm

1. Initialise the depth buffer and frame buffer so that for all buffer positions (*x*, *y*)

   depthBuff(x, y) = 1.0

   frameBuff(x, y) = bgColour

Depth-Buffer Algorithm (cont…)

2. Process each polygon in a scene, one at a time

   – For each projected (*x*, *y*) pixel position of a polygon, calculate the depth *z* (if not already known)

   – If z < depthBuff(x, y), compute the surface colour at that position and set

     depthBuff(x, y) = z

     frameBuff(x, y) = surfColour(x, y)

   After all surfaces are processed depthBuff and frameBuff will store correct values

Calculating Depth

At any surface position the depth is calculated from the plane equation as:

$$z = \frac{-Ax - By - D}{C}$$

For any scan line adjacent *x* positions differ by ±1, as do adjacent *y* positions

$$z' = \frac{-A(x+1) - By - D}{C} \qquad z' = z - \frac{A}{C}$$

Iterative Calculations

The depth-buffer algorithm proceeds by starting at the top vertex of the polygon

Then we recursively calculate the x-coordinate values down a left edge of the polygon

The x value for the beginning position on each scan line can be calculated from the previous one

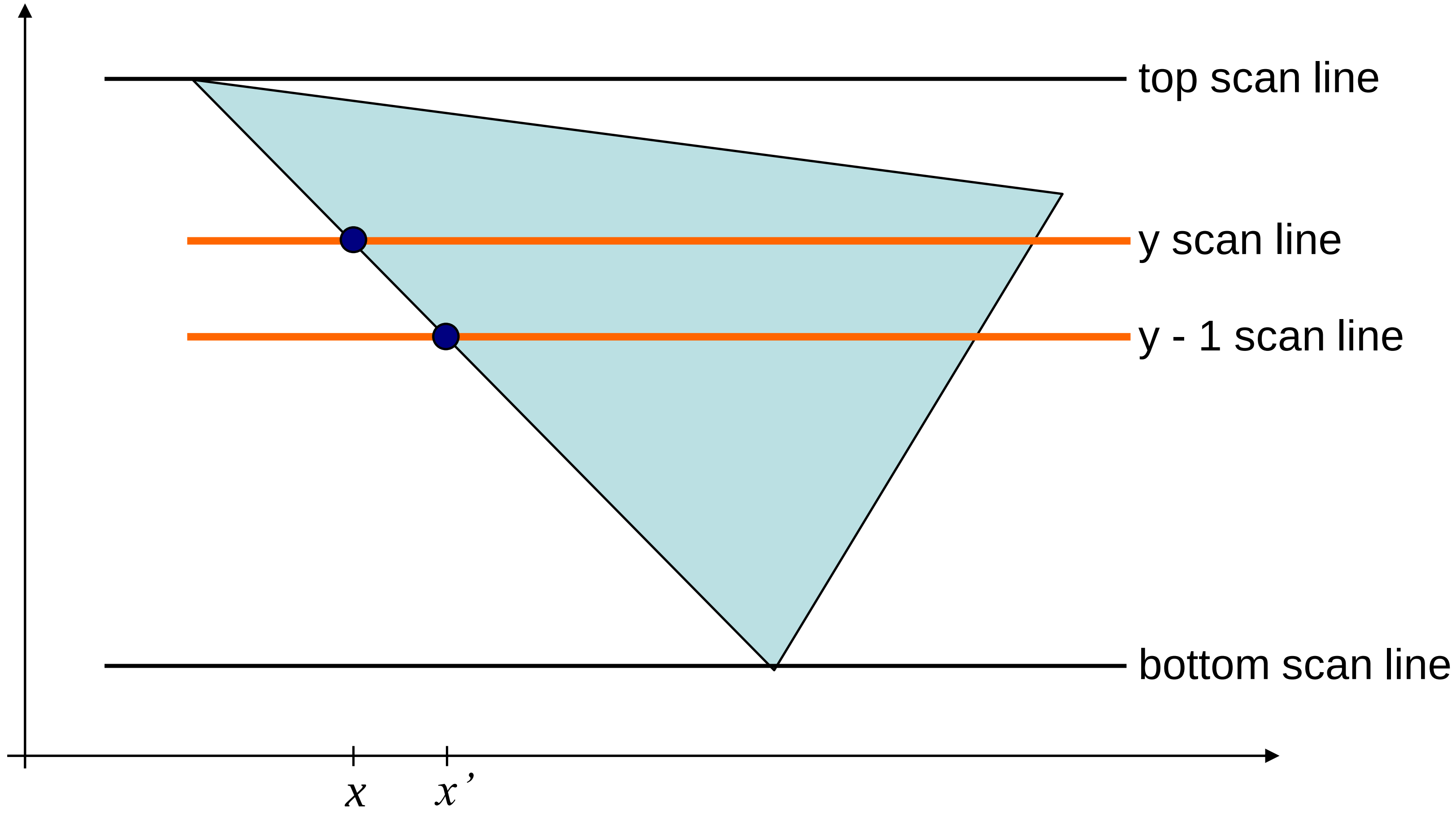
$$x' = x - \frac{1}{m}$$ where m is the slope

Iterative Calculations (cont…)

Depth values along the edge being considered are calculated using

$$z' = z - \frac{{}^{A}\!/_{m} + B}{C}$$

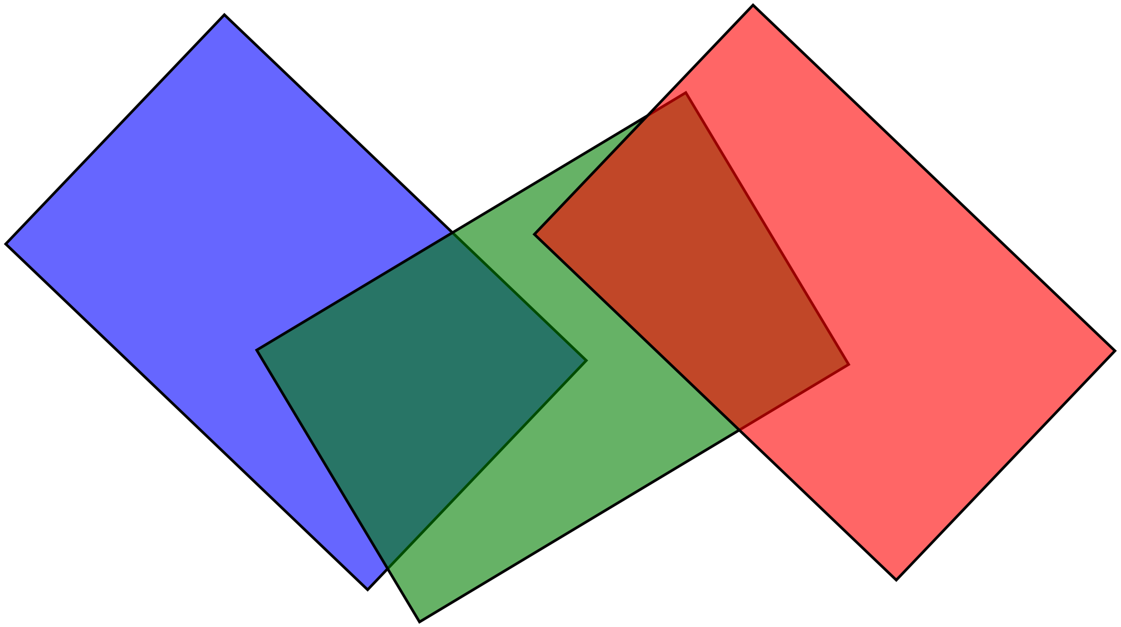
Iterative Calculations (cont…)



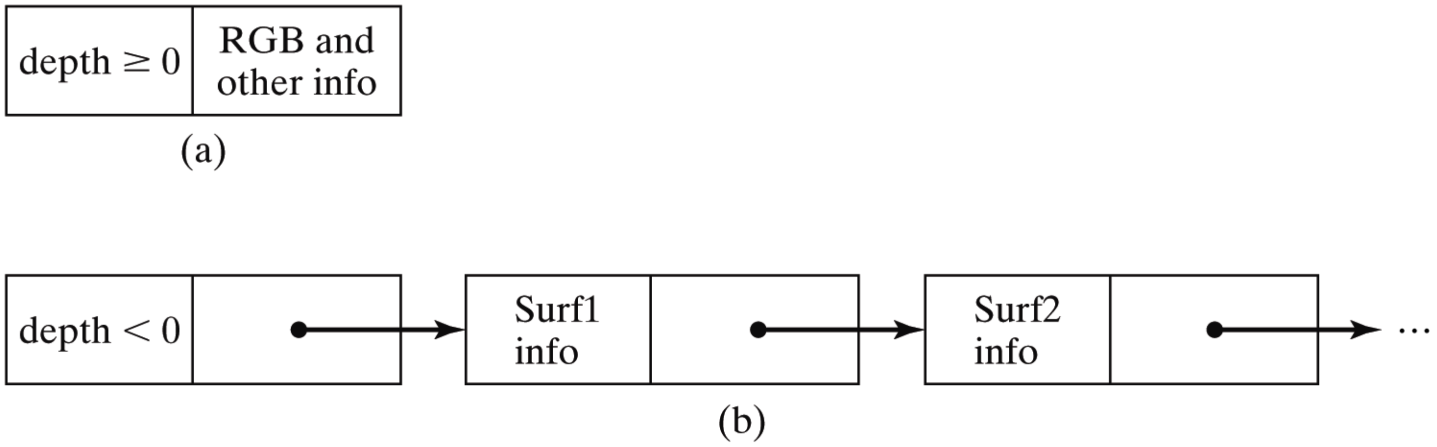
A-Buffer Method (cont…)

The A-buffer expands on the depth buffer method to allow transparencies

The key data structure in the A-buffer is the *accumulation buffer*



A-Buffer Method (cont…)



(a)

(b)

If depth is >= 0, then the surface data field stores the depth of that pixel position as before

If depth < 0 then the data filed stores a pointer to a linked list of surface data

Summary

We need to make sure that we only draw visible surfaces when rendering scenes

There are a number of techniques for doing this such as

- – Back face detection
- – Depth-buffer method
- – A-buffer method
- – Scan-line method