Chapter 15
Shadows

Z-Buffer Shadow Generation
- Object is in shadow if not “seen” by light source
- Idea - compute visibility from light source to decide if shadowed

Z-Buffer Shadow Algorithm
- Render scene from light-source “viewpoint”
- For each pixel save z depth instead of color
- Render scene from eye view point
- Map every (visible) non-background pixel to light source space (perspective transformation)
- Compare z values
  - If identical - pixel illuminated by light source (add light source to its illumination equation)
  - If not, it is shadowed
- Need to repeat rendering & projection for each light source

Properties
- Can shadow ANY scene which can be rendered using Z-buffer
- However - requires separate memory buffer for each light source
- Every polygon rendered \(N+1\) times (for \(N\) light sources)
  - \(N\) views do not need lighting calculations

Shadow Volumes
- Shadow – boundary between illuminated & shades space
- Compute as extrusion of silhouettes along light direction
- Compute intersection of extruded volume with other objects

Shadows
- Realistic illumination includes shadows cast by objects
- Simple shadow generation methods
  - Z-buffer extension
  - Shadow volumes
- Advanced – ray-tracing & radiosity

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Shadows from 2 light-sources

Shadow volumes circa Leonardo daVinci
Shadow Volumes

- Shadow Volumes illustrated (2D)

- Light source
- Eye position
- Shadowing object
- Surface outside shadow volume (illuminated)
- Shadow volume (infinite extent)
- Partially shadowed object
- Surface inside shadow volume (shadowed)

Algorithm

- For each object and light source compute object silhouette from light source viewpoint
- Extend each silhouette to form semi-infinite volumes
- Feed boundaries into regular Z-buffer as fully transparent polygons
- Front facing shadow polygons cause object behind to be shadowed
- Back facing shadow polygons cancel effect of front facing ones
- Consider vector from viewpoint to point on object - point is shadowed if vector intersects more front facing polygons than back facing

Properties

- Object space - does not depend on viewpoint
- High complexity per object
- Time - function of scene complexity
- Requires modeling methods
  - Silhouette computation
  - Extrusion