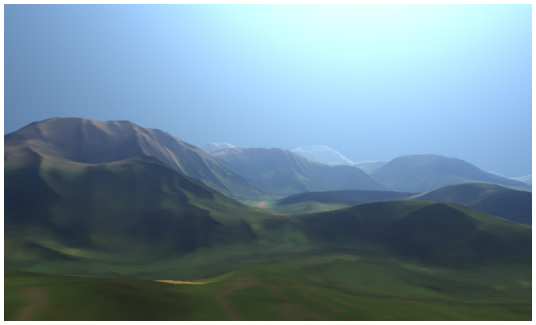
Monthly Report : *Real-time Global illumination techniques for outdoor lighting:*

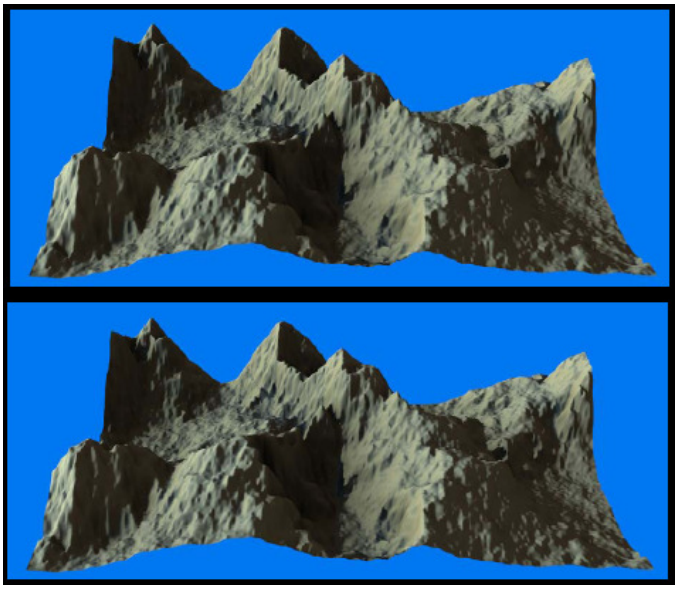
1) Dynamic Rendering Outdoor Light Scattering in Real Time - **Naty Hoffman**
- Rendering Atmospheric Light Scattering over time, weather and pollution.
- Dealing with Absorption, Out-scattering, In-scattering.



Rayleigh Scattering

Mie scattering approximation

2) Ambient Aperture lighting
- Using pre-computed visibility information to calculate shadows (Hard + soft)
- Similar to horizontal mapping but allows for area light source (circular)
- Soft shadow is computed by intersecting visible area and light source area.



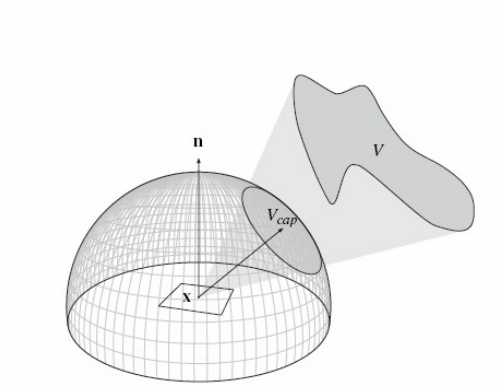
Result : top exact result – bottom approximate result.

3) Crytex real-time Ambient Occlusion

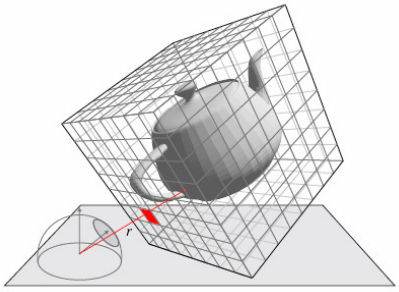
- General Concept:
    - Update, reconstruct AO real-time based on: position, normal, light color with relative attenuation radius.
    - Geometry Occlusion is preprocessed → limitation: works for only static scene and memory consuming.
    - Advantages : dynamic AO lighting

4) Ambient Occlusion Fields:

- Idea: compute the shadow cast by an occluder at an arbitrary position and surface orientation in the neighborhood:
    - Pre-pocessing: Approximate occluder with an spherical cap – direction and solid angle. (for each position, storing a pair of solid angle - Ω(x) and direction Y(x))

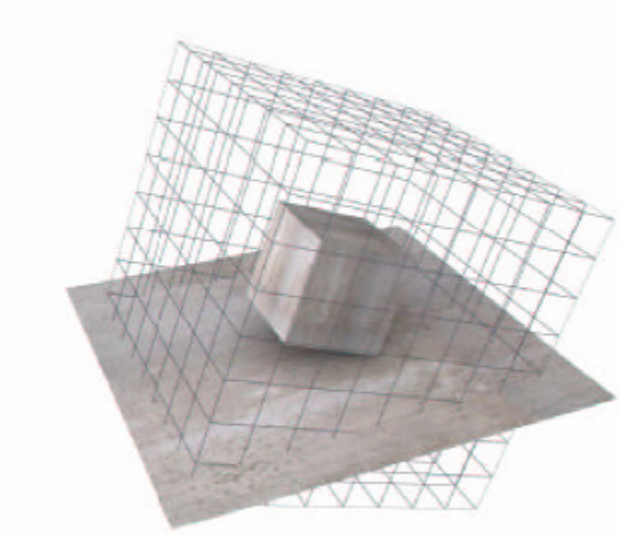


    - Runtime: determine AO levels by projecting current rendering position into cube map and fetch the pair of pre-computed solid angle - Ω(x) and direction Y(x)

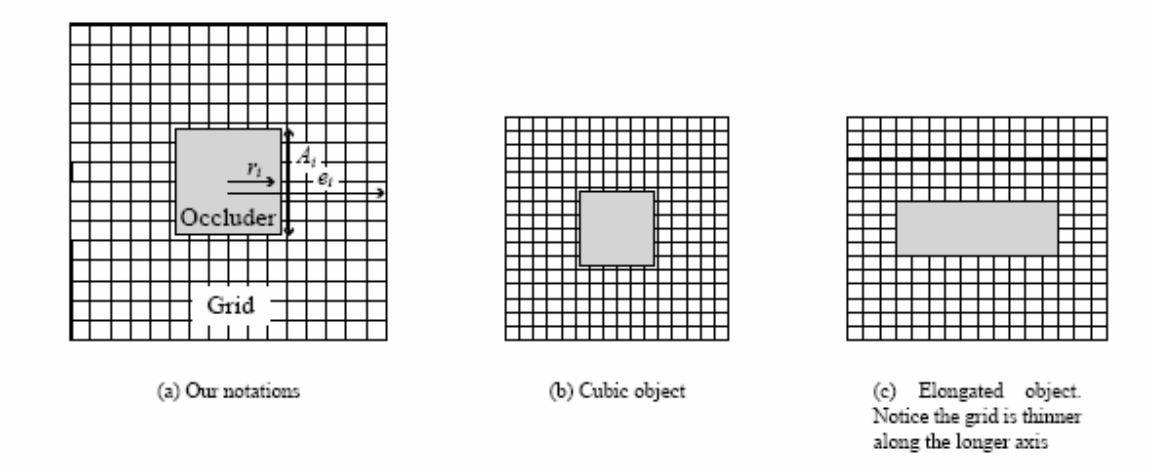


    - Limitation :
        - In order to approximate occluder projected volume onto spherical cap needs a lot of pre-computed solid angle - Ω(x) and direction Y(x) → slow for complex objects.
    - Result :

5) Faster precomputed AO for Proximity shadows:
    a. Extend the "Ambient Occlusion Fields" from cube map → 3D texture.
    b. Instead of storing the direction and solid angle, storing single percentage of occlusion instead.



    c. Optimize storage by using elongated box – reduce memory needed:

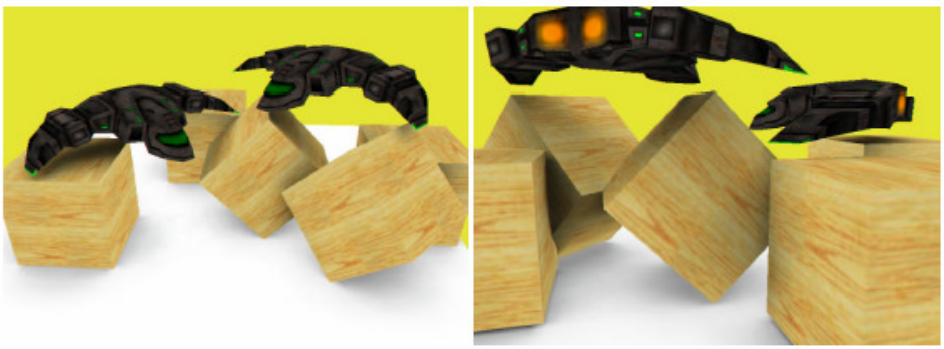


(a) Our notations

(b) Cubic object

(c) Elongated object. Notice the grid is thinner along the longer axis

    d. Result:



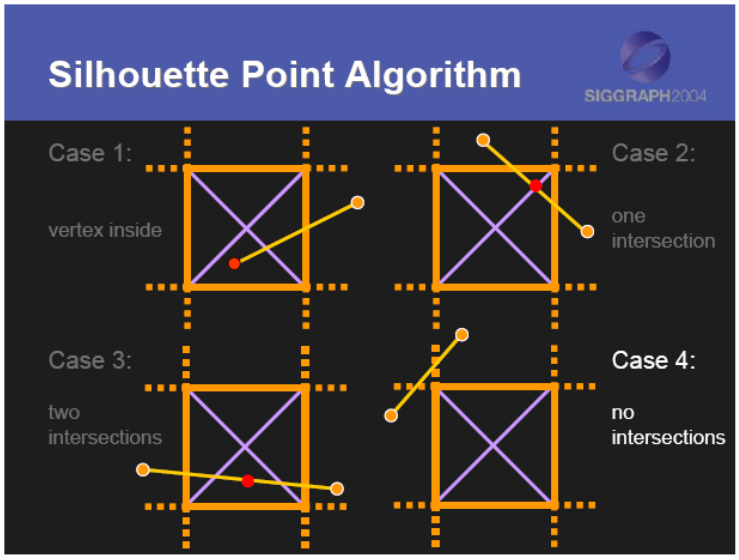
(a) (b)

Figure 8: Ambient occlusion values, accounting for the normal of the occluder and the direction of occlusion (80 to 130 fps)

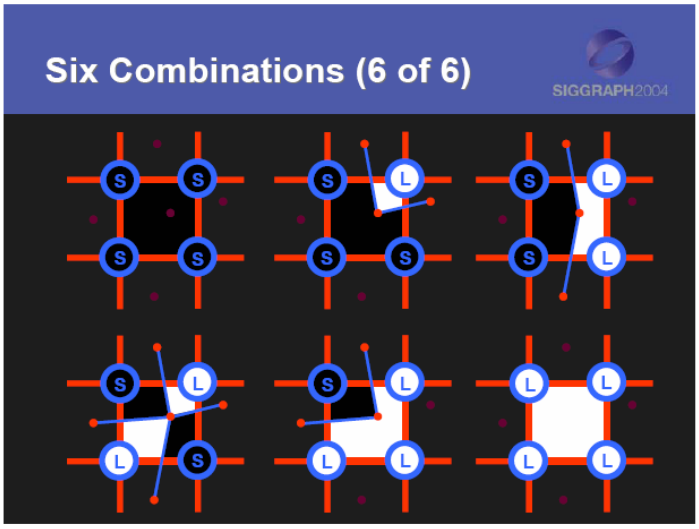
e. Limit: Needs even more memory to stored 3D texture.
f. Advantages: more accurate due to reconstruct AO area in 3D space rather than cubemap.

6) Real-time shadow techniques – 2004 siggraph

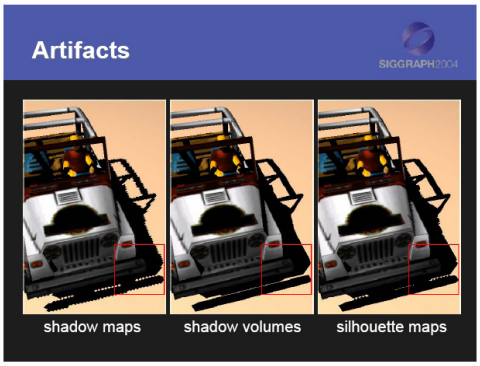
- Idea: Improve shadow mapping by using silhouette edges cue.
  - 1st pass: Rendering normal depth buffer.
  - 2nd pass: Rasterize silhouette edges into temporary buffer (same size of depth buffer) and storing intersection point coordinates.



  - 3rd pass: Rendering shadow by using intersection point coordinates to clip the depthbuffer.

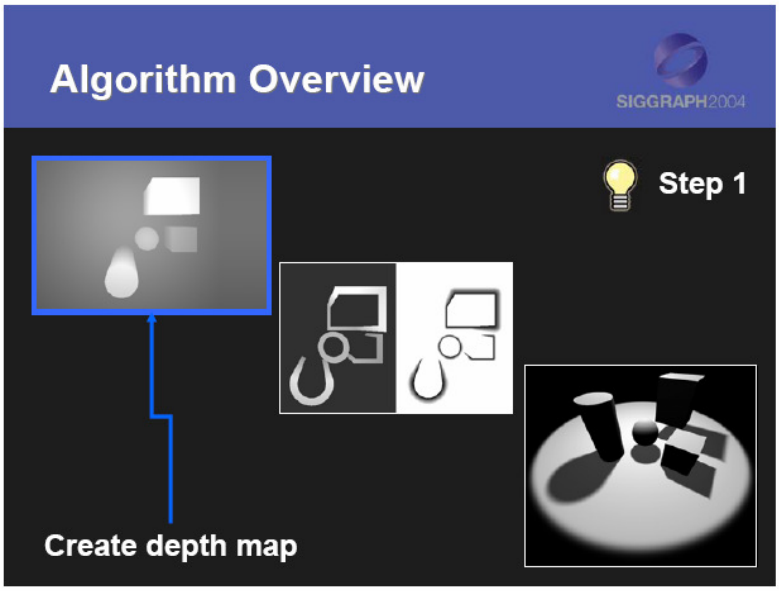


- Advantages:
    - Remove aliasing artifacts from traditional shadow mapping due to limited depth buffer resolution.

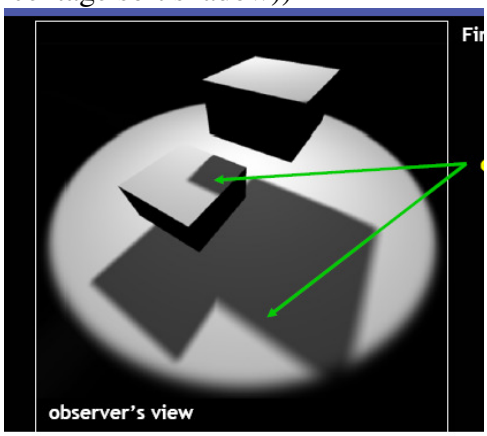


- Disadvantages:
    - More complex algorithm on 2nd and 3rd pass to render silhouette shadow. This is the trade-off for shadow quality.

7) Fake soft shadow:
- Idea:
    - Rendering fake soft shadow by
        - 1st : rendering traditional shadow map
        - 2nd : employ depth information from 1st rendering to extend the shadow smooth boundary outward (smoothie)
        - 3rd : combine normal shadow map with extended soft shadow boundary



- Result : qualitative improvement of shadow with cheap fake soft shadow (compared to real soft shadow methods that requires many texture sampling (i.e. percentage soft shadow))



- Disadvantages:
  - Fake shadow: shadow becomes bigger rather smaller due to area light source.