Ambient Occlusion

CS535

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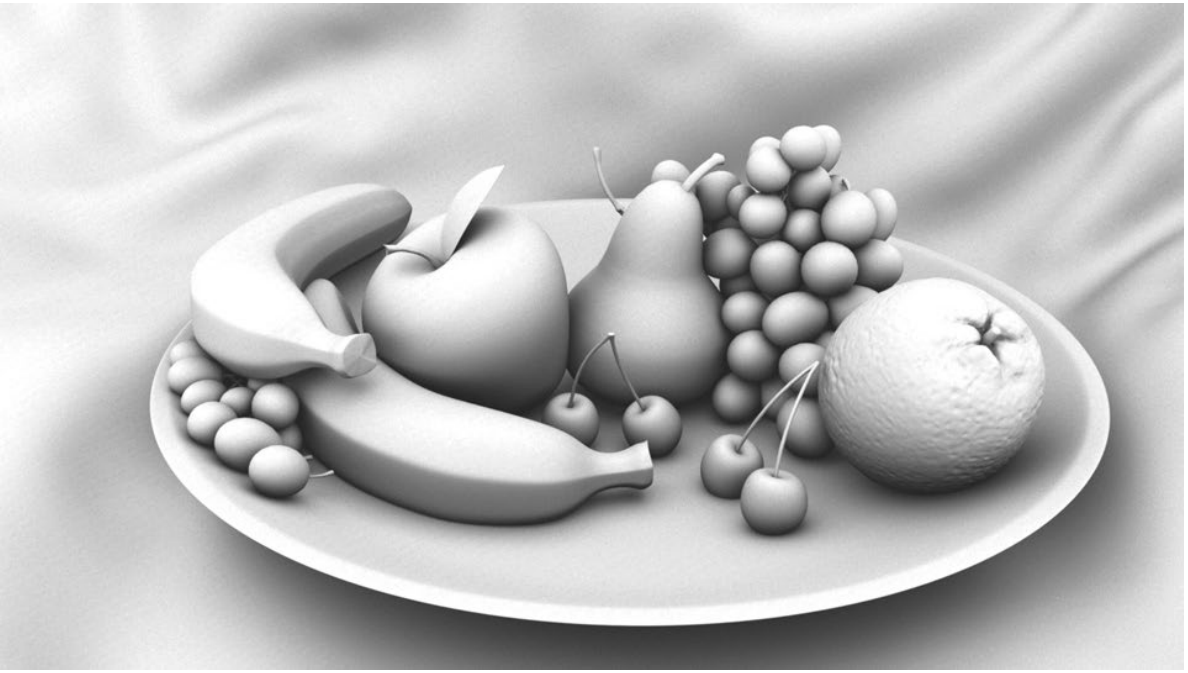
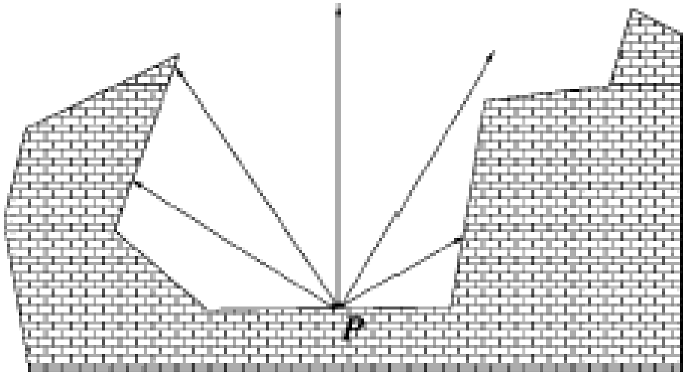
Ambient Occlusion

- It is a lighting technique to increase the realism of a 3D scene by a “cheap” imitation of global illumination

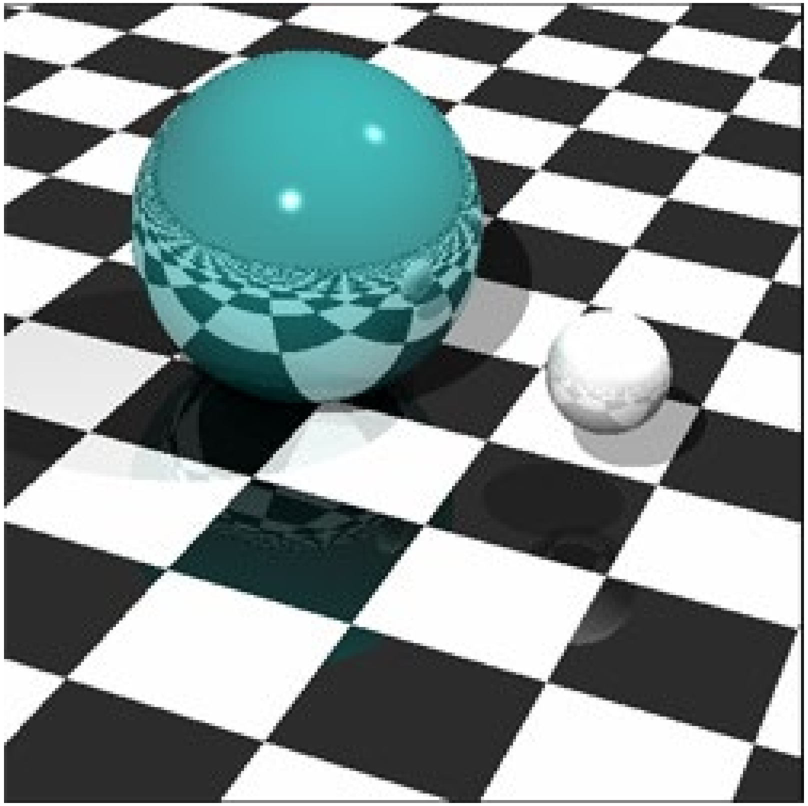


History

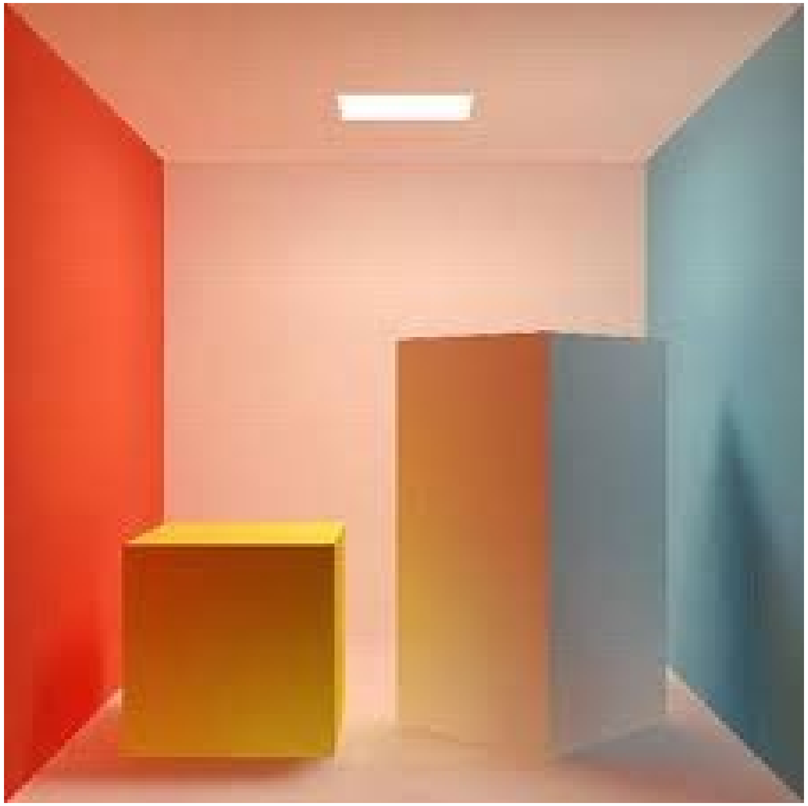
- In 1998, Zhukov introduced *obscurances* in the paper “An Ambient Light IlluminationModel.”
- The effect of obscurances : we just need to evaluate the *hiddenness* or occlusion of the point by considering the objects around it.



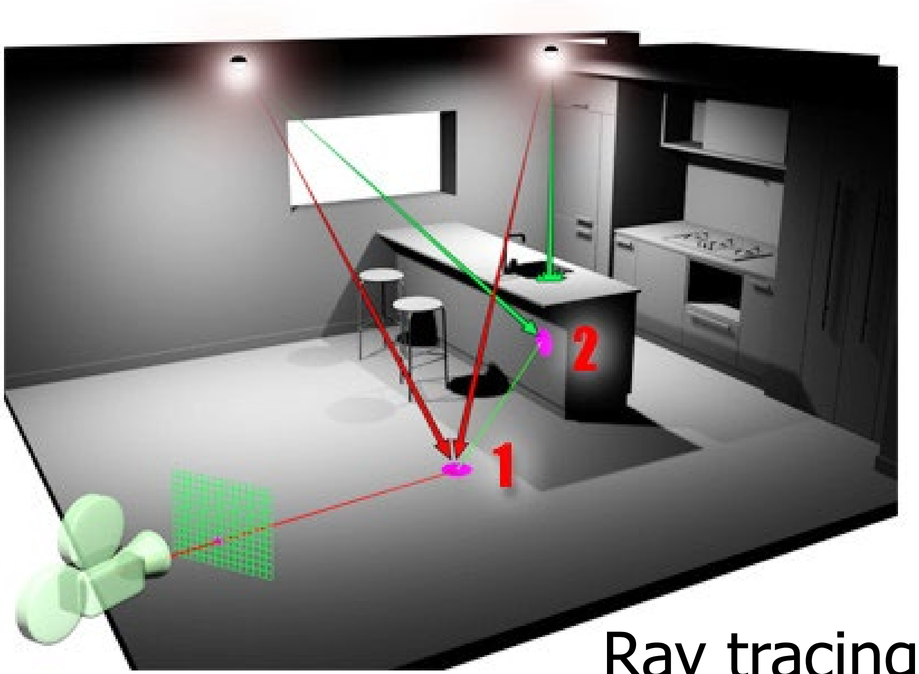
Global Illumination



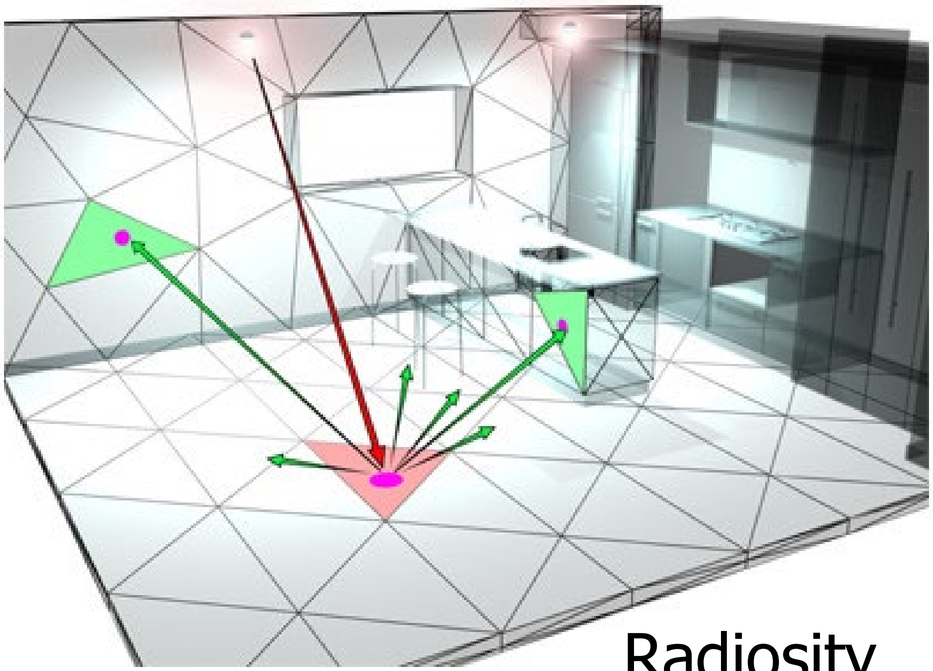
Ray tracing



Radiosity



Ray tracing

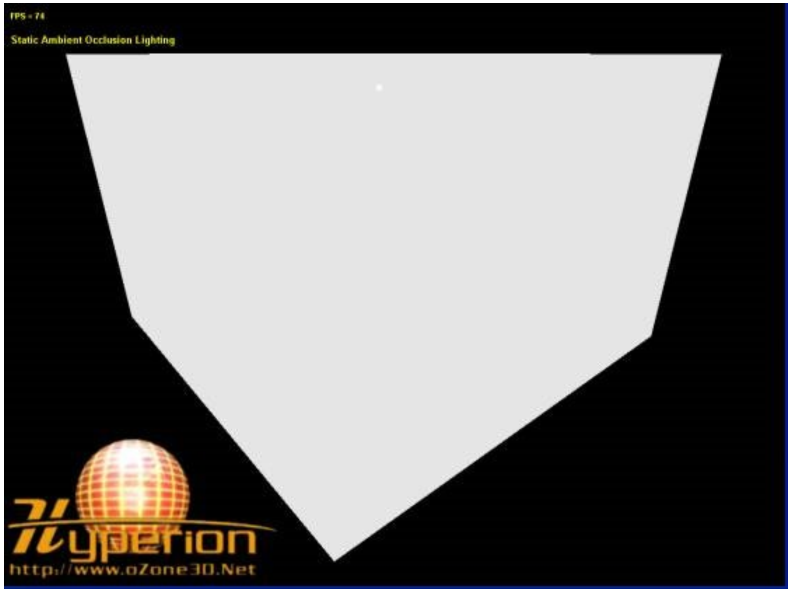


Radiosity

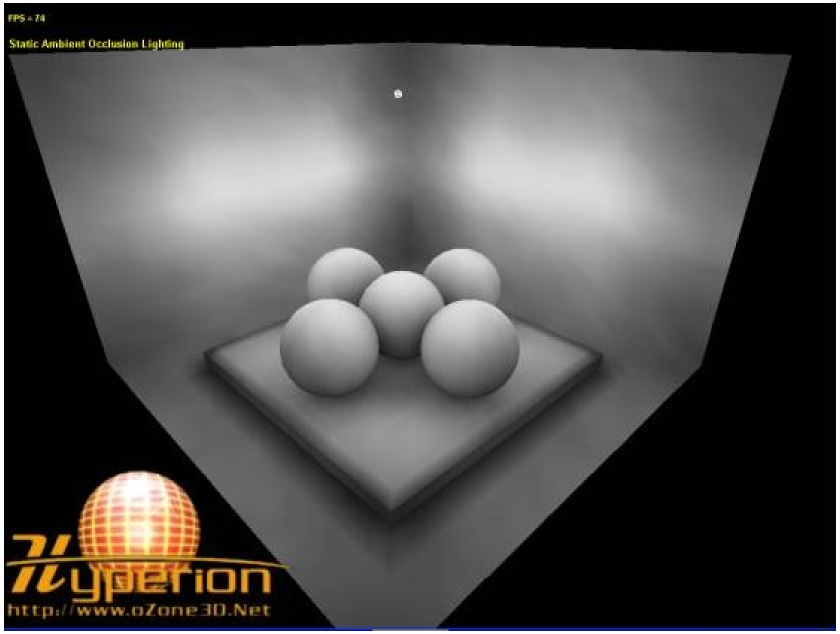
Phong Illumination Model

$$I = I_a + I_d + I_s$$

$$I_a = IA \cdot occ(v)$$



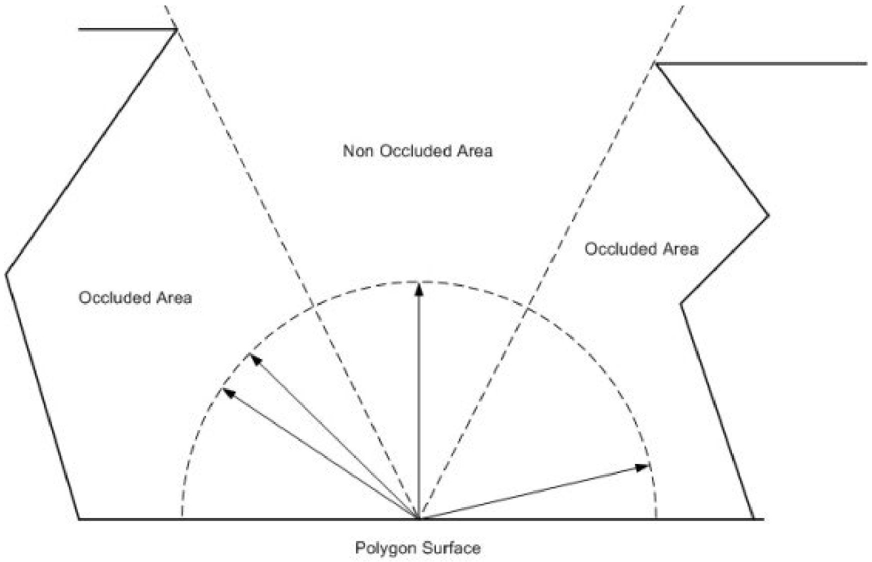
Constant ambient intensity rendering



Modulate the intensity by an occlusion factor

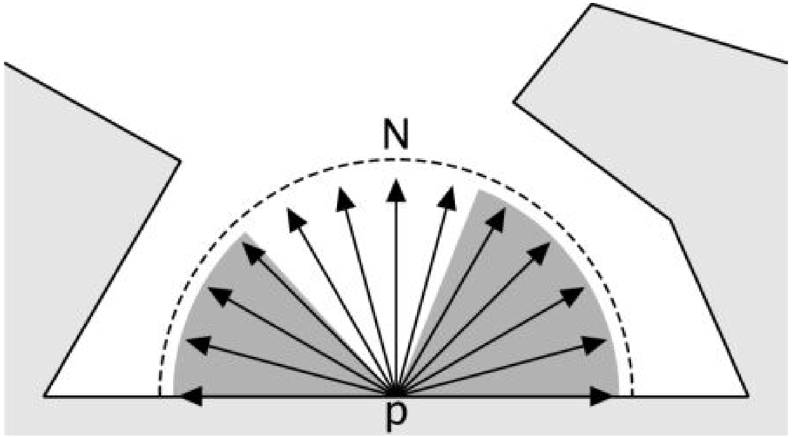
Occlusion Factor/Map

- Shooting rays outwards
- Determine the occlusion factor as a percentage



Inside-Looking-Out Approach: Ray Casting

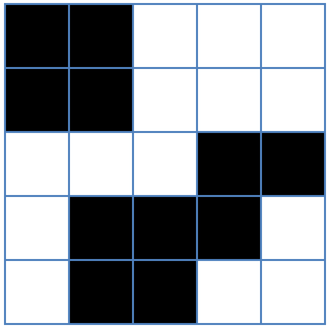
- Cast rays from ***p*** in uniform pattern across the hemisphere.
- Each surface point is shaded by a ratio of ray intersections to number of original samples.
- Subtracting this ratio from 1 gives us dark areas in the occluded portions of the surface.



e.g.: Cast 13 rays
9 intersections
⇨ Color * 4/13

Inside-Looking-Out Approach: Hardware Rendering

- Render the view from ***p*** toward the normal ***N***
- Rasterize black geometry against a white background.
- Take the (cosine-weighted) average of rasterized fragments.

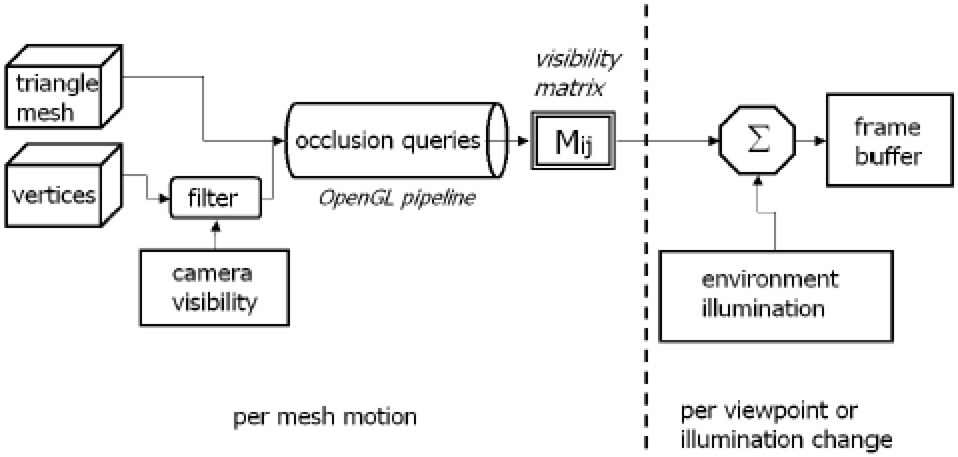


11 black fragments
⇨ Color * 14/25

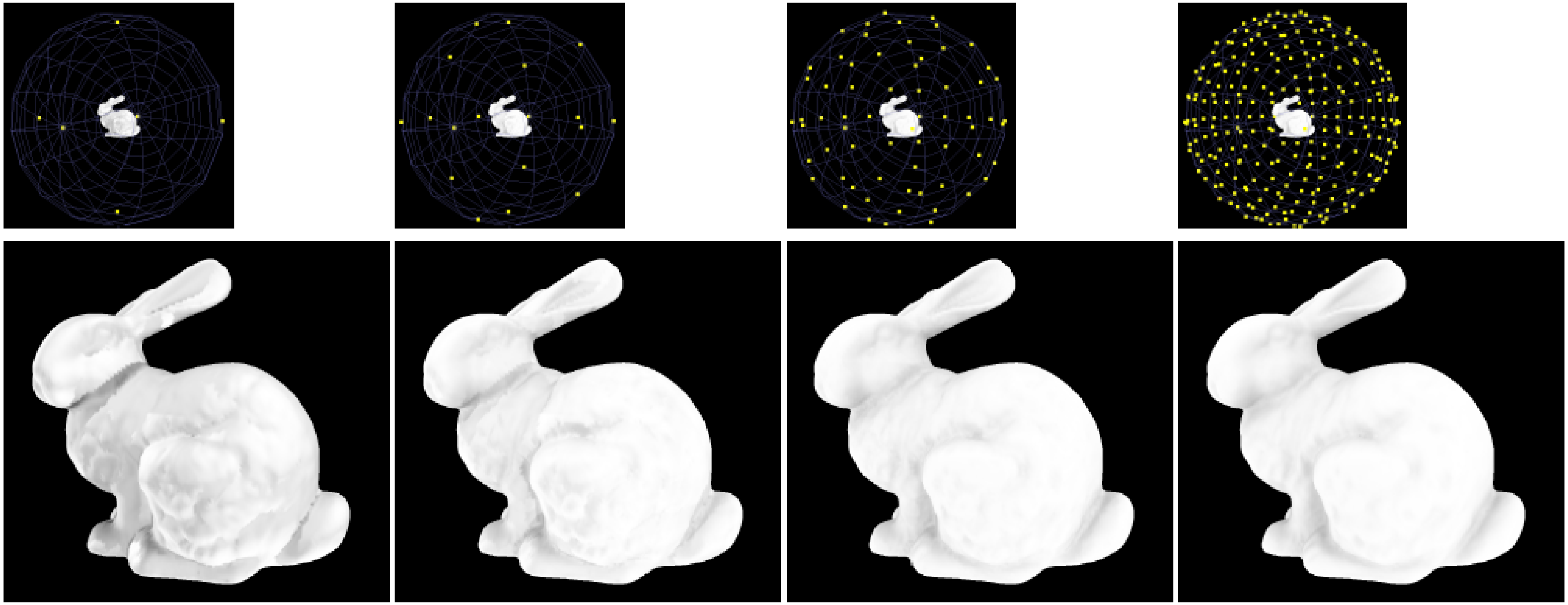
Comments

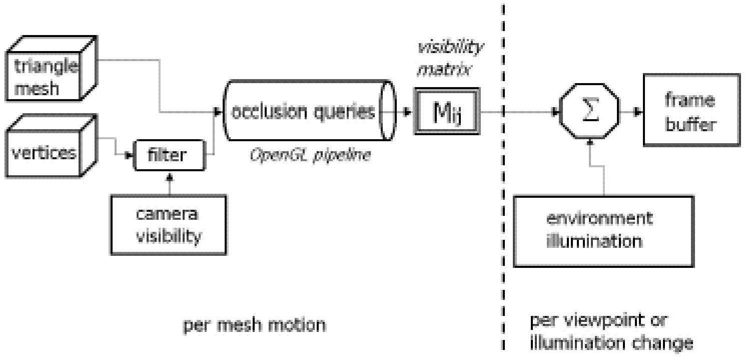
- Huge pre-computation time per scene (20min)
- Store occlusion factor as vertex attributes
- Variations on sampling method
- “Inside-out” algorithm
- “outside-in” alternative

Outside-In Alternative [Sattler et. al 2004]



$$c_i = \sum_{j=1}^{k} M_{ij} I_j$$





```
enable orthographic projection
disable framebuffer
for all light directions $j$ do
    set camera at light direction $\mathbf{l}_j$
    render object into depth buffer with polygon offset
    for all vertices $i$ do
        begin query $i$
        render vertex $i$
        end query $i$
    end for
    for all vertices $i$ do
        retrieve result from query $i$
        if result is ”visible” then
            $M_{ij} = \mathbf{n}_i \cdot \mathbf{l}_j$
        end if
    end for
end for
```

$$M_{ij} = \begin{cases} \mathbf{n}_i \cdot \mathbf{l}_j & : \quad \text{vertex visible} \\ 0 & : \quad \text{vertex invisible} \end{cases}$$

$$c_i = \sum_{j=1}^{k} M_{ij} I_j$$

Sattler et al.

- For each light on the light sphere
- Take the depth map (for occlusion query)
- Use occlusion query to determine the visibility matrix

Image-Based AO

- SHANMUGAM, P., AND ARIKAN, O. 2007. Hardware Accelerated Ambient Occlusion Techniques on GPUs. In Proceedings of ACM Symposium in Interactive 3D Graphics and Games, ACM.

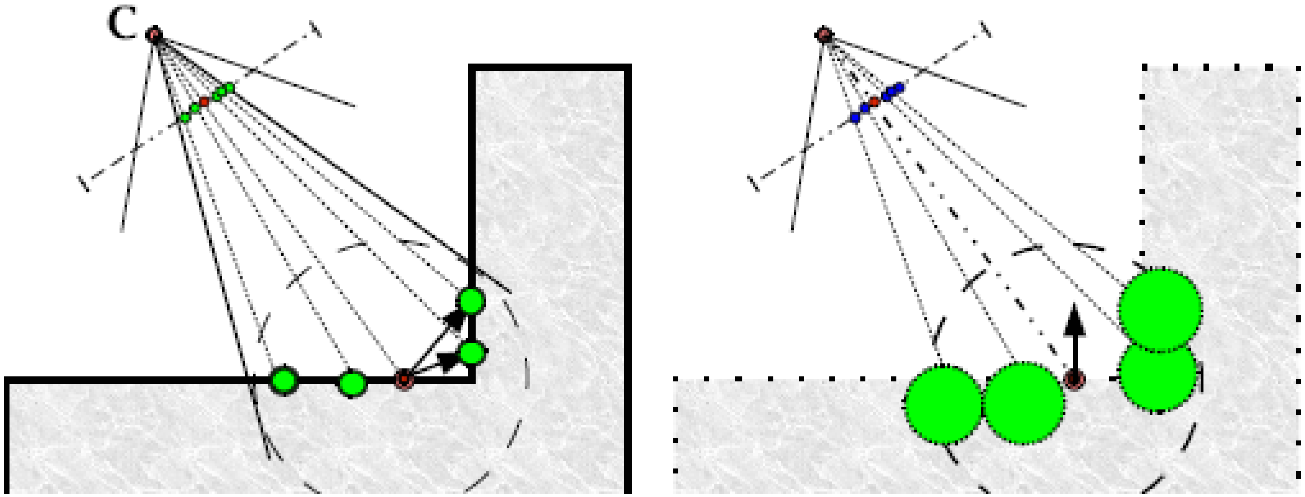


Image-Based AO