Beam Tracing

CS535

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Origins

- Beam Tracing Polygonal Objects, P. Heckbert and P. Hanrahan, SIGGRAPH, 1984
  - leverages the geometric coherence of groups of rays by tracing a volume of rays instead of each ray individually.

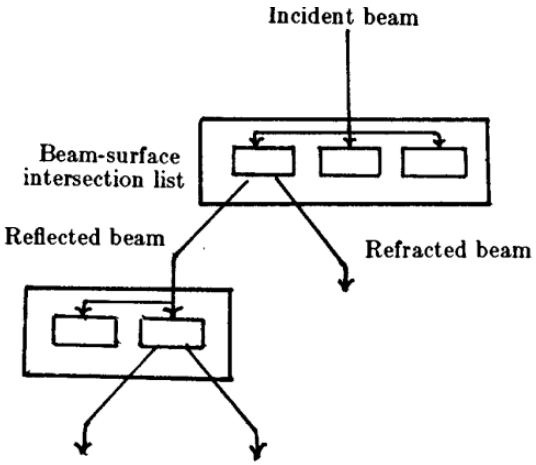


Figure 2. A schematic representation of the beam tree. Notice that the incident beam is fragmented into several pieces each of which may give rise to a reflected and refracted beam.

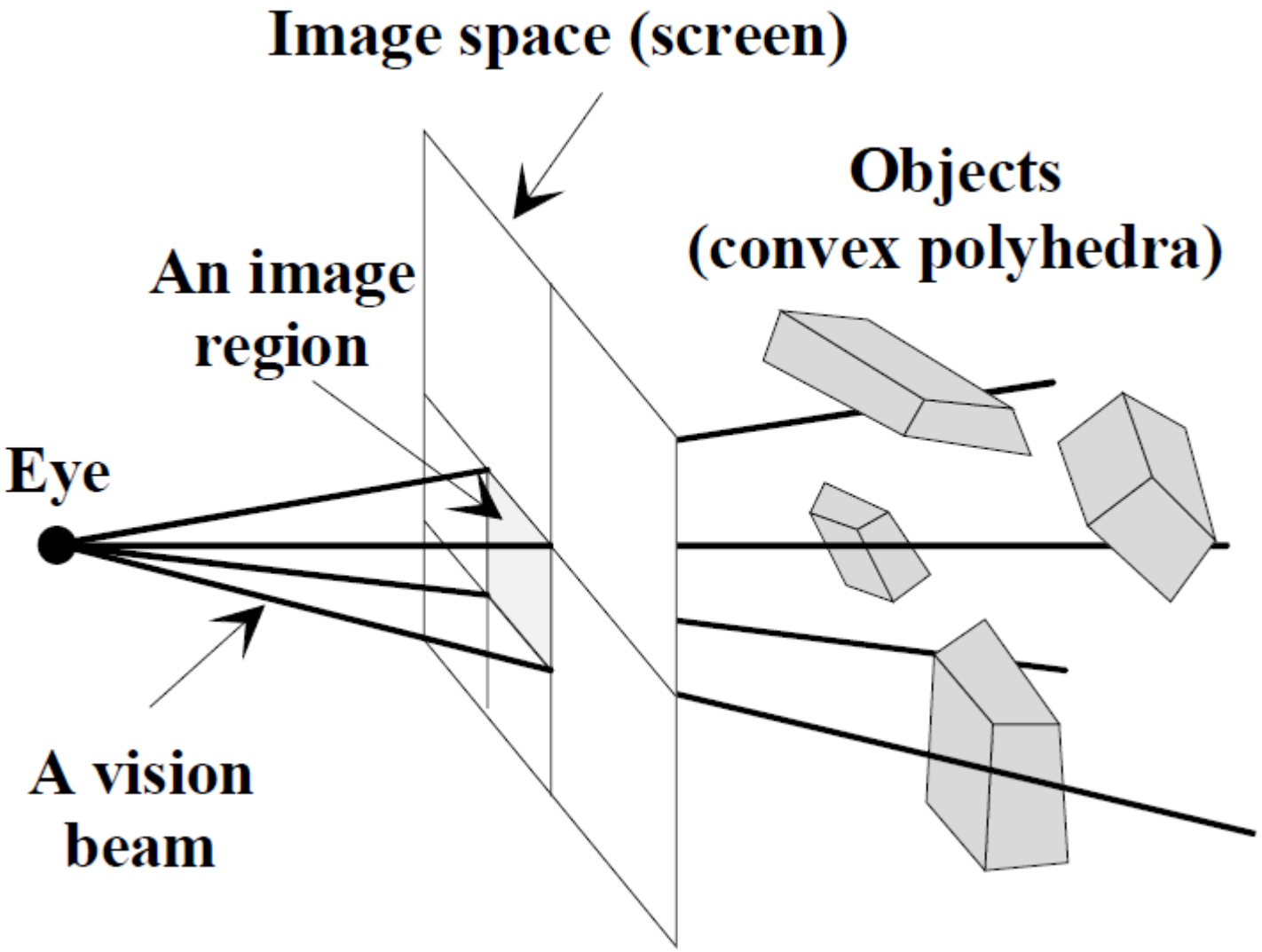
Uses

- Rendering
- Acoustics
  - Beam tracing sounds through architectural interior spaces [Funkhouser and team…]
- Related
  - Cone Tracing (Ray tracing with cones, SIGGRAPH ‘84)
  - Ray Differentials (Tracing ray differentials, SIGGRAPH ‘99)

Modernization

- A Real-time Beam Tracer with Application to Exact Soft Shadows, Overbeck, Ramamoorthi and Mark, EGSR, 2007.
- A Beam Tracing with Precise Antialiasing for Polyhedral, Scenes. Djamchid Ghazanfarpour, Jean-Marc Hasenfratz, SIGGRAPH ‘98

Starting the beam…



Beam Intersections

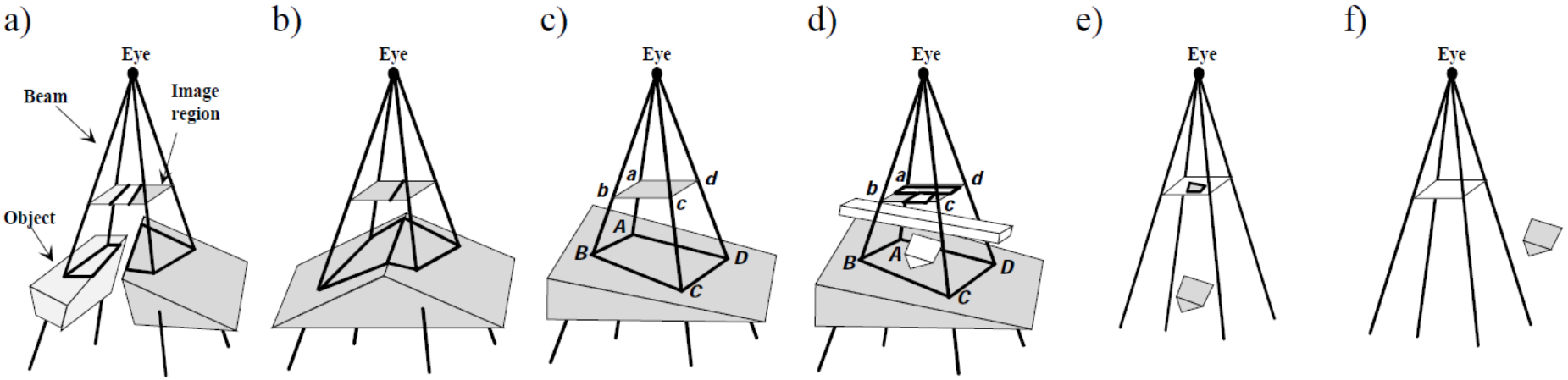


Figure 2 : *Examples of edge-object intersections.*

Shadow Beams

- Once no further subdivision, check for shadow

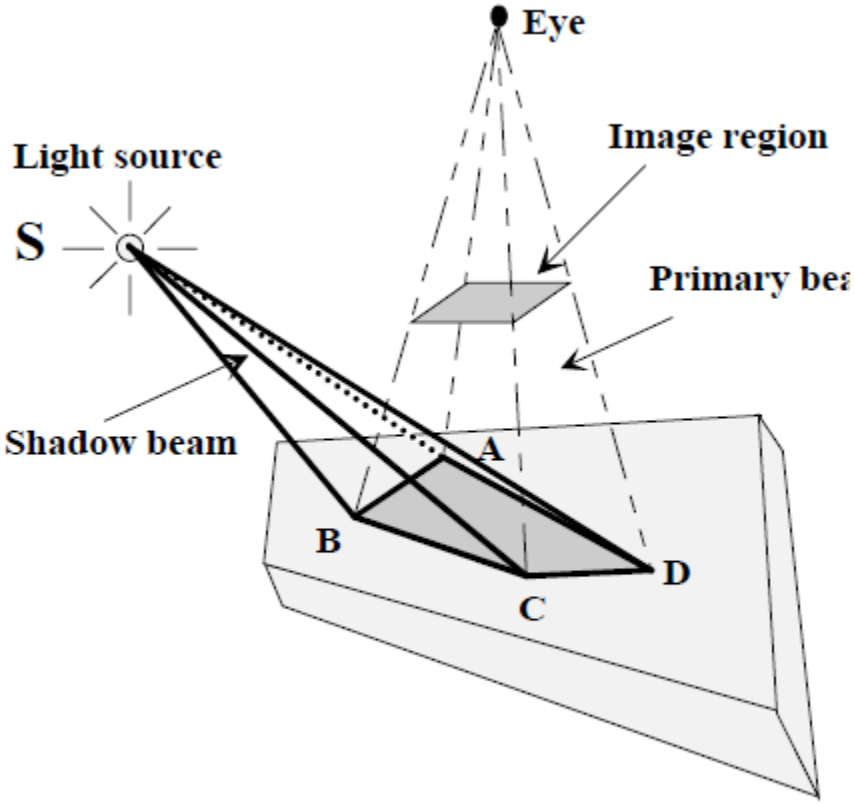


Figure 6: *Shadow beam.*

Reflection Beam

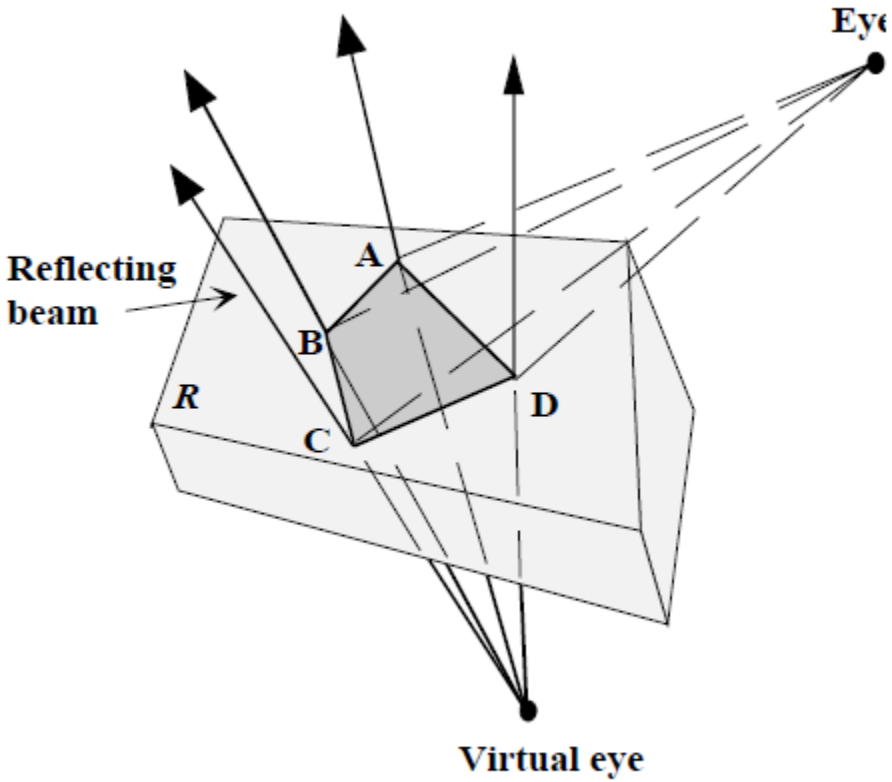


Figure 7: *Reflection beam.*

Refraction Beam

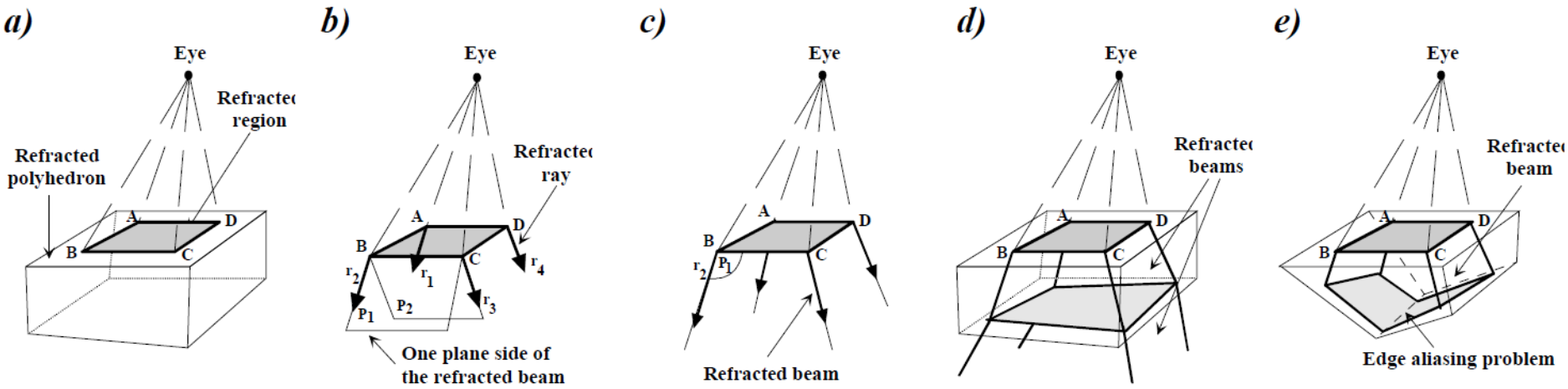


***Figure 8**: **a:** Refraction region, **b** and **c:** plane selection for construction of refraction beam, **d** and **e:** multiple refraction beams.*

Soft Shadow Beam

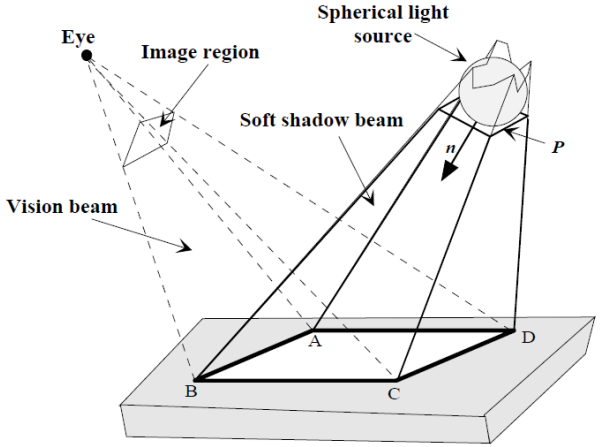


***Figure 10.a**: Shadow beam.*

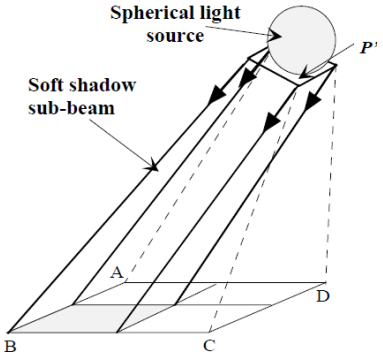


***Figure 10.b**: Subdivision of a shadow beam on a region strictly larger than one pixel.*

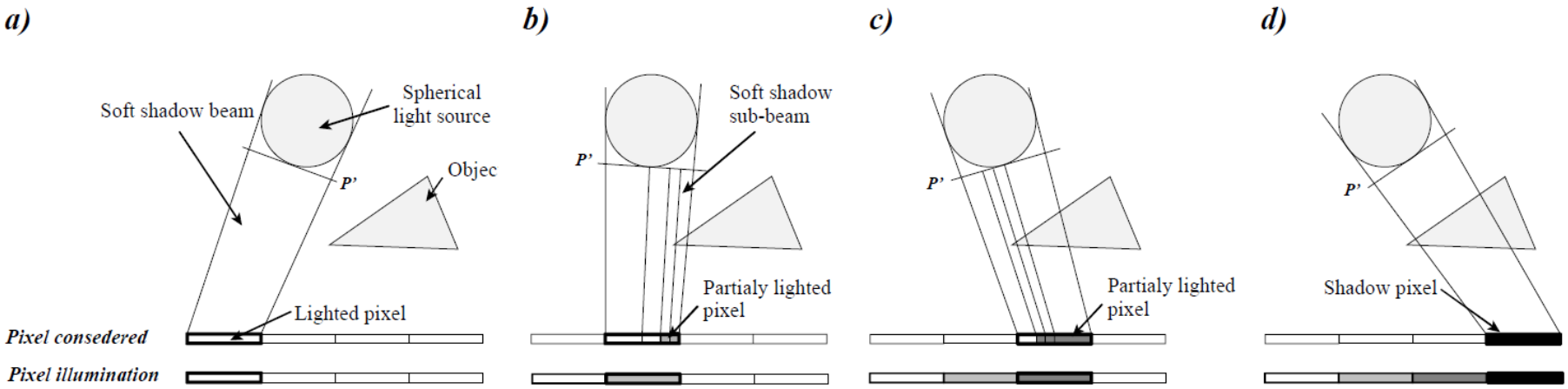


***Figure 13:** Soft shadow example in 2D: illumination of consecutive pixels*

Acoustics

- A beam tracing approach to acoustic modeling for interactive virtual environments, T. Funkhouser, I. Carlbom, G. Elko, G. Pingali, M. Sondhi, J. West, SIGGRAPH ’98

- (then jump forward too…)

- Efficient 2D Sound Propagation in Video Games, N. Davari, C. Verbrugge, AAAI ‘21
  - (deep learning!)

Acoustics

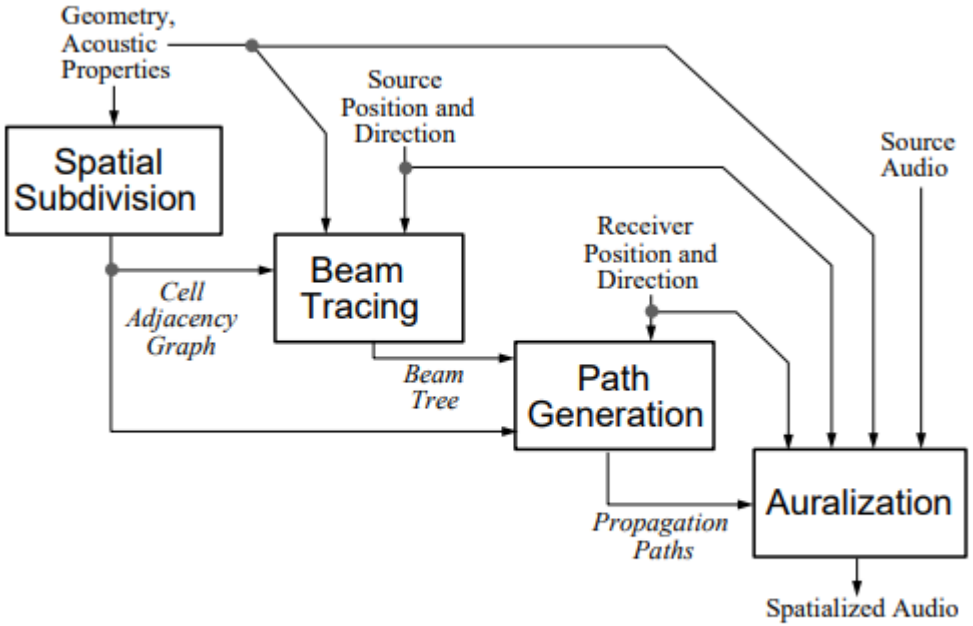


Figure 6: System organization.

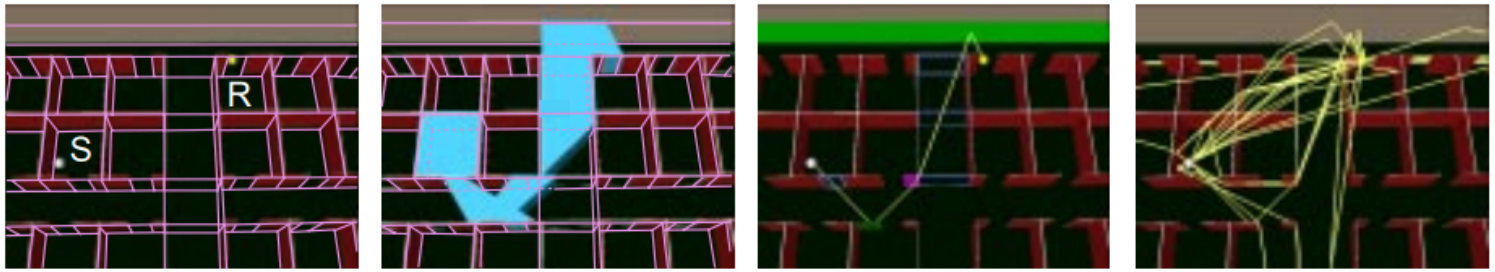


Figure 7: Results of each phase of execution: (a) Virtual environment (office cubicles) with source S, receiver R, and spatial subdivision marked in pink, (b) Example reflected and diffracted beam (cyan) containing the receiver, (c) Path generated for the corresponding sequence of opaque faces (green), transparent faces (purple), and edges (magenta), and (d) Many paths found for different sequences from S to R.

Video

- https://www.youtube.com/watch?v=sfeLzoticJw
  - Markovic et al.