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Reflections on reflections

Reflections—a difficult problem

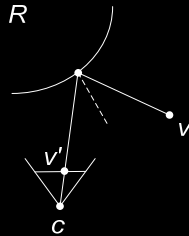
- Every reflector is a portal onto a world which is as rich as the directly observed scene and which has complex image formation laws



2

Reflections—a difficult problem

- Projecting reflected vertices is difficult



3

Reflection methods

Ray tracing	Image-Based Rendering
Feed-forward reflection rendering	Approximation of reflected scene



4

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5

Ray tracing

- General
- Expensive
 - It is hard to trivially reject ray-primitive pairs that do not yield an intersection



6

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7

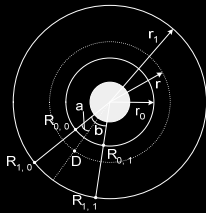
Image-based rendering

- Supports complex real-world reflections
- **Data intensive**
- **Limited support for dynamic scenes**
- Examples
 - View dependent texture mapping
 - Light fields
 - Reflection morphing

8

Reflection morphing

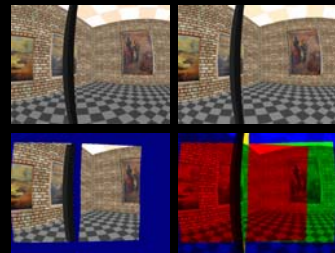
- Idea
 - Use a sparse set of reference reflections and morph between them



Blend reflections R_{ij} with weights a/b and $(r-r_0)/(r_1-r_0)$

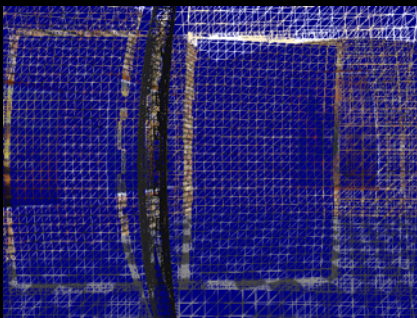
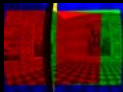
9

Reflection morphing results



10

Reflection mesh visualization



Reflection morphing +-

- Only a few images
- Accurate reflections
- **Static scenes**
- **Scene geometry needed**
- **Disocclusion errors**

12

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13

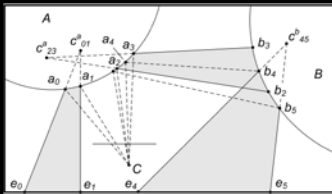
Feed-forward reflections

- Idea: solve problem of projecting vertices
- Explosion maps
- Sample-based cameras

14

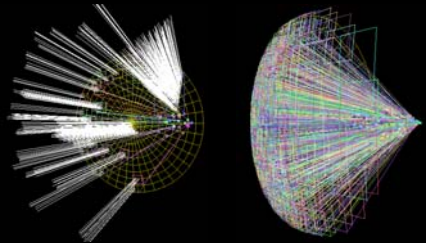
Sample-based camera

- A set of BSP trees with simple cameras at their leaves



15

SBC visualization



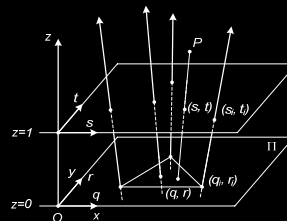
16

Simple cameras?

- Requirements
 - Closed form projection
 - Ability of modeling coherent but not concurrent rays
- Possibilities
 - Planar pinhole camera
 - General linear camera (aka 3-ray camera)
 - K-ray camera
 - Continuous 3-ray camera

17

K-ray camera



Camera model:
 $(q, r, s(q, r), t(q, r))$

Projection:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} q \\ r \\ 0 \end{bmatrix} + \begin{bmatrix} s(q, r) - q \\ t(q, r) - r \\ 1 \end{bmatrix} w$$

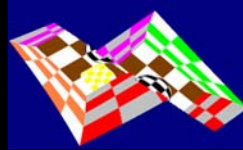
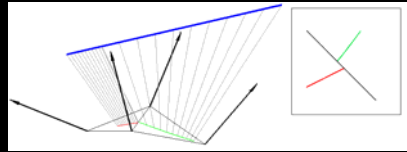
18

K-ray camera examples

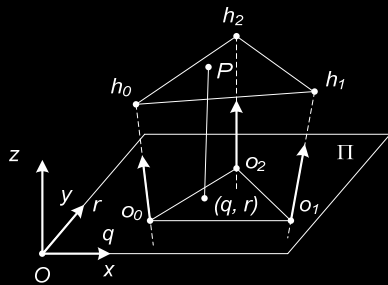
k	Projection equation	Comments
3	Linear	General linear camera [Yu 2004]. Projection discontinuous across shared edge.
4	Quadratic	Bilinear interpolation of 4 rays.
6	Quartic	Most powerful camera with closed form projection
C3	Cubic	Projection continuous across shared edge.



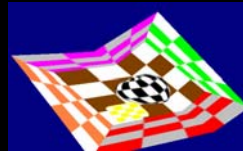
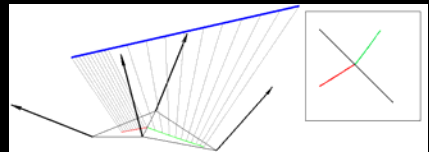
3-ray camera discontinuity



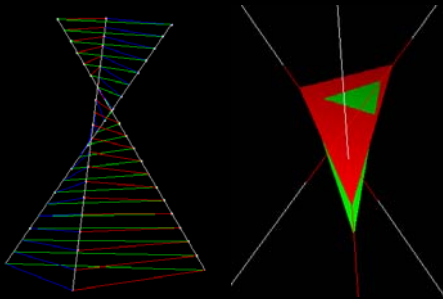
Continuous 3-ray camera (C3RC)



C3RC: continuous projection



C3RC: multiple projections



SBC results



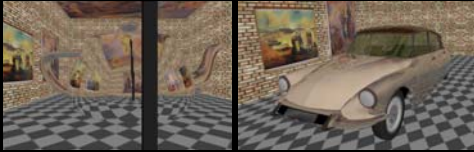
EM, 60 fps.

SBC, 60 fps.

RT, 1 fps.

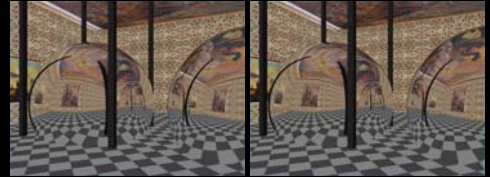


Results: complex reflectors



25

Results: second order reflections



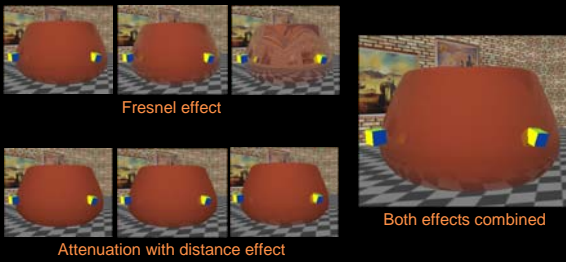
SBC, 24 fps.

RT, 0.5 fps.



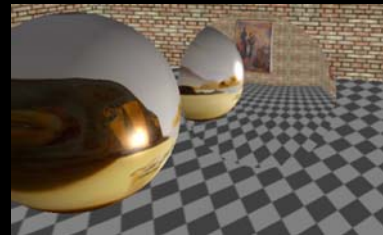
26

Results: complex materials



27

Results: view-dependent lighting

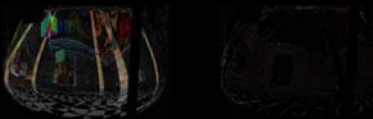


Highlight on reflected object correctly occurs at different location.



28

Results: pixel accurate reflections



Error images



29

Future: extension to refraction



30

Sample-based cameras

- Accurate reflections
- SBC does not depend on reflected scene
- Lack of support for complex reflectors
- Limited support for dynamic reflectors



31

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32