

Environment Mapping



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Overview

- Introduction
- Environment map construction
 - sphere mapping
 - cube mapping, ...
- Environment mapping applications
 - distant geometry
 - reflections
 - bump mapping

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Introduction

- Environment map
 - an image with a large FOV: *panorama*
 - a collection of rays that pass through one point
 - it could cover all possible view directions
 - several types, according to how the rays sample the solid angle
- Applications
 - distant geometry
 - fast (approximate) reflections
 - bump mapping

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Cube mapping



6 x 90°x90° images

- same COP
- frames form 6 faces of a cube

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Cube mapping construction

- By rendering
 - render scene for each of the 6 faces
- Acquisition using camera
 - take overlapping pictures by rotating camera around COP (construction images)
 - undistort each construction image
 - register images in common coordinate system
 - build cube map
 - for every pixel of every face (“for each ray in the panorama”)
 - project on each construction image
 - blend colors from all construction images that had the current ray

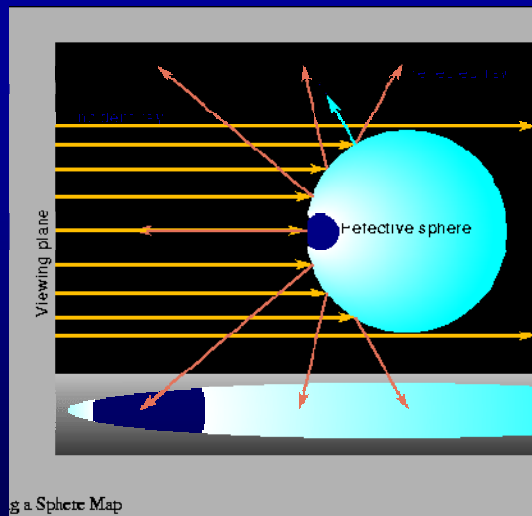
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Cube mapping

- Simple math for construction and lookup
- Fairly uniform sampling
- 6 separate images that need to be acquired, stored and processed

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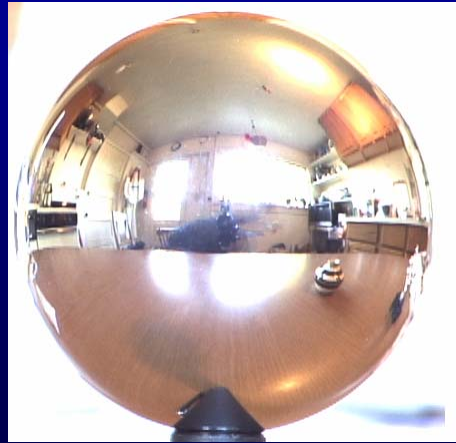


Sphere mapping

- The image of a small shiny sphere seen from far away
- Incoming rays are parallel
- Covers all directions
- Sampling varies considerably

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Acquisition using camera



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Acquisition using camera



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Acquisition using camera



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Acquisition using camera



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Sphere mapping

- More expensive math for construction and lookup
- Non-uniform sampling
- Can be acquired with one photo but
 - camera visible in the map
 - light probe does not float in mid air

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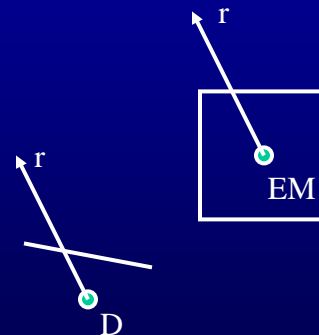
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Rendering distant geometry ("environment")

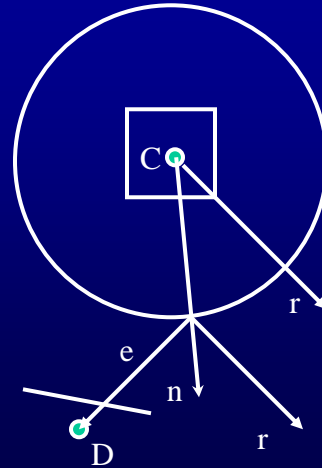
- Environment map stores distant geometry as seen from the center of the scene (EM)
 - clouds, mountains, moon, stars, sun etc.
- Instead of clearing the frame buffer, set it to the appropriate part of the environment
 - look up each desired ray in the env. map as if the environment map was taken from the current position of the camera (D)
 - assumption valid because distance to environment much greater than distance from center of scene (EM) to current position (D)



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Efficient (but approximate) reflections

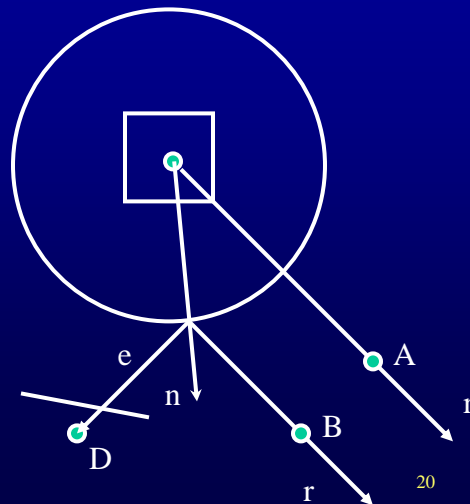
- Acquire (render or capture) the environment map from the center C of the reflector
- Run time algorithm
 - if scene changed re-render environment map
 - for each reflector
 - for each triangle
 - for each visible inside pixel
 - » compute normal (n)
 - » compute eye vector (e)
 - » compute reflected ray (r)
 - » look it up in the env. map (r)



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Limitations

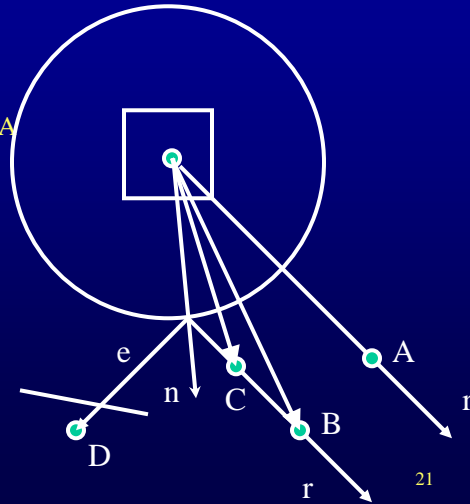
- Incorrect reflections
 - A instead of B
- No motion parallax
- No inter-reflections
- No multiple reflections



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Limitations

- Incorrect reflections
- No motion parallax
 - rendered image always: C, B, A
 - correct: C, A (B hidden)
 - correct (not shown): B, C, A
- No inter-reflections
- No multiple reflections



Limitations

- Incorrect reflections
- No motion parallax
- No inter-reflections
- No multiple reflections

