Environment Mapping

Overview

• Introduction
• Environment map construction
  – sphere mapping
  – cube mapping, ...
• Environment mapping applications
  – distant geometry
  – reflections
  – bump mapping
Overview

• Introduction
• Environment map construction
  – sphere mapping
  – cube mapping, …
• Environment mapping applications
  – distant geometry
  – reflections
  – bump mapping

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
Overview

• Introduction

• Environment map construction
  – spheric mapping
  – cube mapping, …

• Environment mapping applications
  – distant geometry
  – reflections
  – bump mapping
Cube mapping

6 x 90°x90° images
- same COP
- frames form 6 faces of a cube

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
Cube mapping

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

Sphere mapping

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

Acquisition using camera
Acquisition using camera
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

Overview

• Introduction
• Environment map construction
  – sphere mapping
  – cube mapping, …
• Environment mapping applications
  – distant geometry
  – reflections
  – bump mapping
Overview

• Introduction
• Environment map construction
  – sphere mapping
  – cube mapping, …
• Environment mapping applications
  – distant geometry
  – reflections
  – bump mapping

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)
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)

Limitations

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