Real-Time Video Capture for Illumination Reconstruction in Augmented Reality Applications

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1. Project Goals

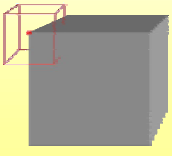
- Reconstruction of a real environment for illumination of virtual object in a most realistic manner
- Real-time usage should be possible to keep up the augmented-reality illusion
- Interactive illumination-reconstruction

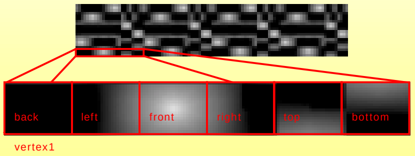
3. Pre-Processing

- Pre-Processing is essential to get real-time results
- Occlusion Information and cosine weighting are pre-processed

Examples for the pre-processing:

- Taking a simple cube object
- Results are stored as textures for later usage

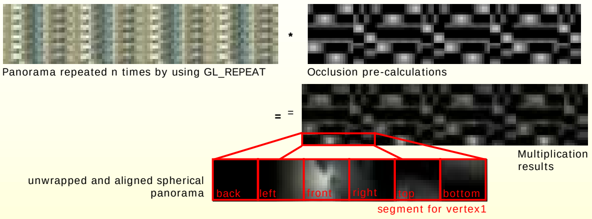




Resulting occulions and cosine weightened pre-process.
Cube-Map for the first vertex is zoomed out.

5. Rendering

- The Pre-Processing image and the unwrapped environment cube-map are multiplied using multi-texturing abilities of modern graphics hardware.



- All pixels of each segment are then summed up to one value
- The resulting value is the color of one of the models vertices
- The summation is also done on the graphics hardware
- We use vertex-texture capabilities of the GeForce6 chipsets to map the colors the corresponding vertices.
- Finally the object has to be rendered using the computed light-values.

AR-Toolkit Marker and the general assembly

- Every operation of the illumination process has been done on the GPU using off-screen buffers and fragment / vertex shaders
- Slow CPU-to-CPU read-backs have been avoided which results in a real-time performance of the system

2. Basic Concept

- Smooth shading and convincing diffuse Illumination
- Simplifications of global illumination concepts to provide real-time results
- Simplified Assumptions:
  1. Static objects
  2. No interreflections
  3. Environmental reconstruction using one lightsample instead of reconstructing the whole environment

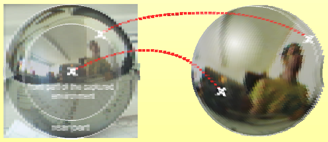
4. Sphere Capturing

- A mirror sphere is used to capture the environment
- AR-Toolkit markers can be used to calculate the screen / video-position of the sphere
- The separated sphere is unwrapped and transformed into a cube-map of the environment
- This cube-map fits the pre-processing cube-maps in size and orientation

AR-Toolkit Marker and the general assembly

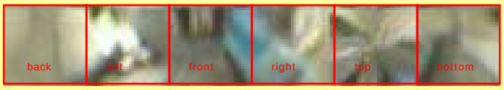
Calibration Mode

Automatically separated sphere



The captured sphere is then texture mapped onto a sphere to calculate the environment cube-map

- The resulting cube-map is stored in a texture, too.



Reconstructed environmental cube-map

6. Results

- Our sample implementation provides real-time integration of high resolution meshes into arbitrary low-frequency lighting environments
- It features soft shadowing and color bleeding effects
- The Buddha model (as seen below) has 32k vertices and runs at 40 frames per second
- The system could also be used to integrate objects into complex virtual scenes with pre-computed lighting

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