Modifying Reality Virtually

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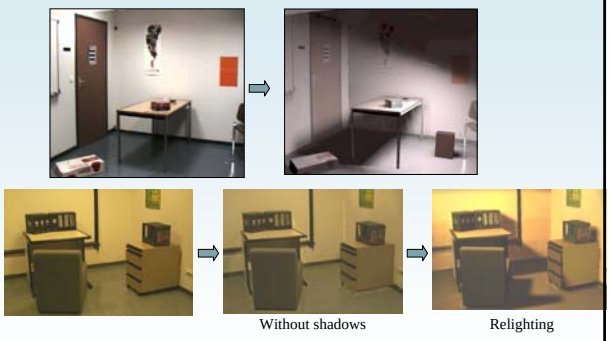
Motivation

- We can use reality as a basis and enhance it with virtual modifications
  - Object insertion/removal
  - Relighting

Previous work



C. Loscos, G. Drettakis, L. Robert: Interactive virtual relighting of real scenes. IEEE Transactions on Visualization and Computer Graphics 6.3, July-September 2000

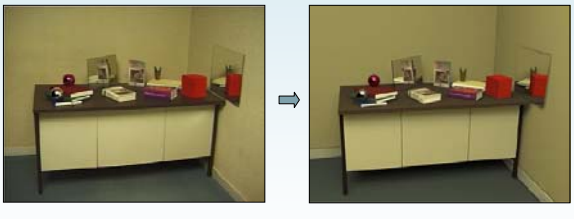
Previous work

C. Loscos, M.C. Frasson, G. Drettakis, B. Walter, X. Granier, P. Poulin: Interactive virtual relighting and remodeling of real scenes. In rendering techniques '99 (Proceedings of the 10th Eurographics Workshop on Rendering), pp235-246, June 1999

Previous work

Y. Yu, P. Debevec, J. Malik, T. Hawkins: Inverse global illumination: recovering reflectance models of real scenes from photographs. In Proceedings of the 26th annual conference on computer graphics and interactive techniques. ACM press, pp 215-224, 1999

Previous work



original re-rendered

S. Boivin, A. Gagalowicz: Image-based rendering of diffuse, specular and glossy surfaces from a single image. In proceedings of the 28th annual conference on Computer Graphics and Interactive Techniques, ACM press, pp 107-116, 2001

General Problems with Complex, Uncontrollable scenes

- **Geometry**
  - Some (outdoor) scenes contain **many details difficult to model**
    - buildings, trees, fauna, people, cars, …
  - Some (outdoor) scenes are **less easy to control**
    - people passing, cars driving, objects moving because of wind

General Problems with Complex, Uncontrollable scenes

- **Illumination**
  - complex illumination
    - direct: Sun
    - indirect: Sky & Objects
  - difficult to control
    - sun intensity too high to capture with camera
    - clouds drifting in sky have significant effect on stability outdoor illumination

Solutions

- Geometry
  - geometry loss can be compensated for by using image processing techniques as shadow detection/object recognition
  - movements during HDRI capturing can be compensated

Solutions

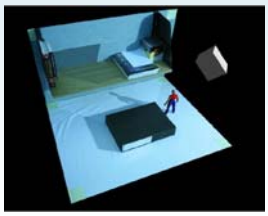
- Illumination
  - detect illumination changes and compensate
  - use homogenous filter to reduce sun intensity
  - capture light probe at different positions in the scene

Automatic shadow detection and shadow generation for augmented reality

K. Jacobs, C. Angus, C. Loscos, J.D. Namias, A. Reche, A. Steed, Graphics Interface 2005.

Aim

- Consistent shadows when inserting virtual objects in a real scene
  - With only approximate geometry needed
  - With no knowledge on the over lighting
  - With no inverse illumination necessary

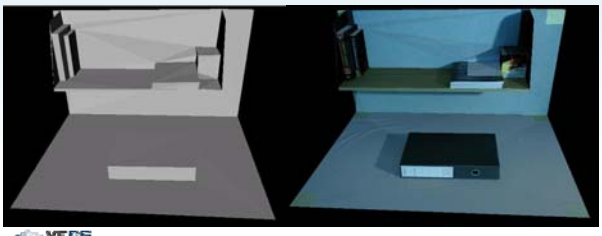


Our solution

- 3 steps method
  - Get a rough geometric model of the scene and the light source position
  - Identify the shadow regions
  - Project the shadows of the virtual objects while protecting the ones of real objects
- Limited to scenes
  - One light source only
  - Hard shadows or semi-soft shadows only
- But interactive (near real time)
- And automatic: no user intervention required

Geometry extraction

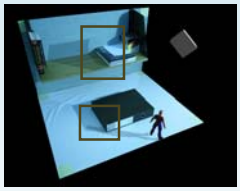
- Reconstruct a real scene
- **Roughly** identify the position of a point light source

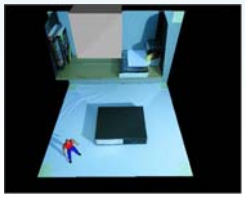


Easy?

- Add virtual objects and generate their shadows using shadow volumes

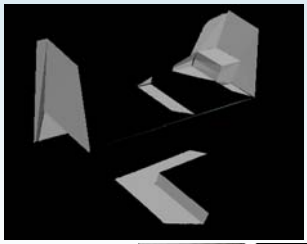
⇨ Problems in areas containing already existing shadows





Our method

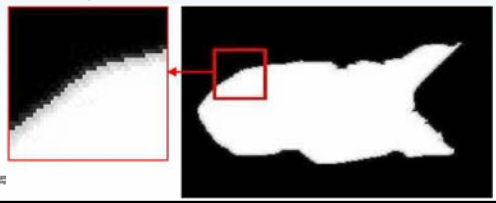
- Mask existing shadow areas in the texture



- Mask creation:
Canny edge detector + region growing

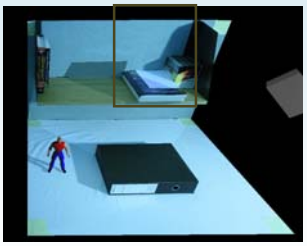
Current implementation

- One identified light source
  - Could be lift with some work
- Hard shadows / Semi-soft shadows
  - We take it a little in consideration in the shadow detection step

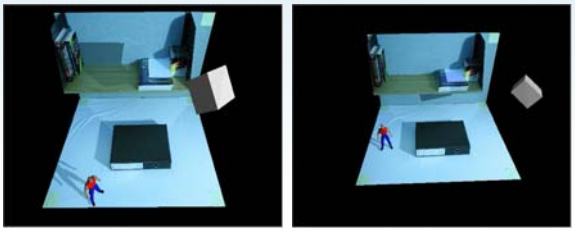


Common illumination

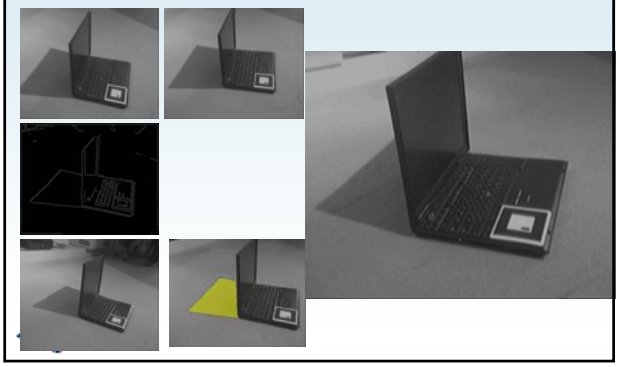
- Mask these regions before rendering virtual shadows using shadow volumes
- Apply the appropriate scaling factor



Results



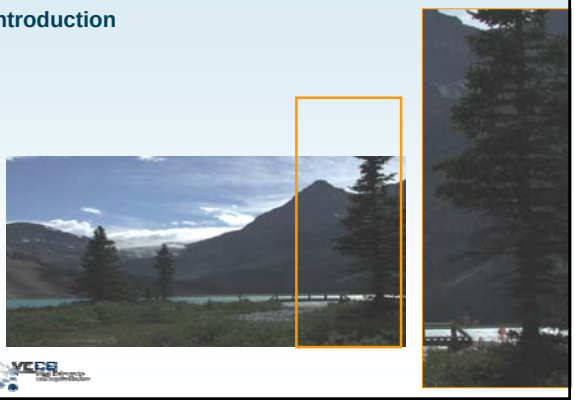
Results



Automatic generation of HDRIs for dynamic scenes

K. Jacobs, G. Ward, C. Loscos,
ACM SIGGRAPH technical sketches, 2005.

Introduction



Methodology & results

1. Alignment exposures using MBT prior to camera curve calibration
2. HDRI generation proceeds in the usual manner
3. Detect pixels in HDRI that correspond to motion region in the different exposures (HCM & LCM)
4. Substitute those pixels in the HDRI by the values from 1 exposure
5. Choose that exposure that shows the least saturation for that particular region

Alignment

MBT: median bit transform

- Threshold each exposure with the median intensity value, for each exposure use a different threshold
- Calculate translational misalignment
- Calculate rotational misalignment
- Iterate between the two

Detection of movement

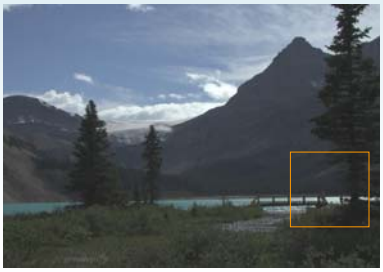
HCM: high contrast movement

- Background and moving objects have high contrast
- Motion pixels show high variance between different exposures
- Calculate variance image and threshold, dilate and erode image to extract regions of pixels in motion area

Variance image

Detection of movement

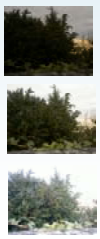
HCM: high contrast movement



Detection of movement

LCM: low contrast movement

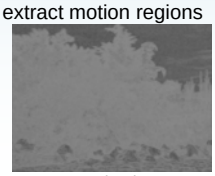
- background and moving objects have low contrast
- Variance will be low in motion regions



Detection of movement

LCM: low contrast movement

- Background and moving objects have low contrast
- Variance will be low in motion regions
- Different measure based on entropy
- Calculate uncertainty image and threshold, dilate and erode image to extract motion regions



uncertainty image

Detection of movement

LCM: low contrast movement

Future work

- Capture
  - Dynamic scene, illumination non controllable
- Relighting and inverse illumination
  - Many different types of objects, Complex illumination
    - Trees, water, people, etc.