Modeling and Rendering Architecture from Photographs

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SIGGRAPH 2000 Course #19, 3D Photography
Brian Curless and Steve Seitz, organizers

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www.debevec.org
The Chevette Project 1991
Modeling and Rendering Architecture from Photographs (Debevec, Taylor, and Malik 1996)

Block Model  User-Marked Edges  Recovered Model
Façade Blocks

Parameterized Block
Blocks

Block 1
- type: wedge
  - length
  - width
  - height

Parameters

- name: "building_length"
  - value: 20.0
- name: "building_width"
  - value: 10.0
- name: "roof_height"
  - value: 2.0
- name: "first_storey_height"
  - value: 4.0

Parameter References
Relation can be:

* Arbitrary 6 DOF
* Fixed Rotation
* Fixed Translation
* Geometric Relationship
Reconstruction Algorithm

An objective function $O$ measures the misalignment between the marked edges and the corresponding projected edges of the model

$O$ is minimized with respect to the model parameters and camera positions

An initial estimate is obtained by a separate procedure
Projected Model

Marked Edge

Model Edge

Error Area

Completed Reconstruction and Reprojection
Algorithm with Initial Estimate Procedure

1. Solve for camera rotations, independently, based on edge orientations

2. Hold camera rotations fixed; solve for other parameters (often linear)

3. Perform full non-linear optimization, starting from near the solution
Video
Photogrammetric Modeling Summary

Modeling with blocks works because:

Convenient for architecture
Recovers Complete Models
Reduces number of model parameters, e.g.

Campanile model has:

2,896 parameters as independent edges
240 parameters as independent blocks
33 parameters as constrained blocks

→ Few marked features required
→ Easier to solve
Surfaces of Revolution

Photograph

Recovered Model

Synthetic View
Arches and Surfaces of Revolution

Taj Mahal modeled from one photograph
Rendering with Projective Texture Mapping
Rendering with View-Dependent Texture Mapping

To render, determine to which triangle the viewpoint belongs

Compute Barycentric weights for the triangle vertices

Render the polygon with a weighted average of the three vertex images

View-Dependent Texture Mapping

View-Dependent Weighting Function
Image-Based Modeling, Rendering, and Lighting

SIGGRAPH 2000 Course #35
Tuesday, July 25, 2000
Room 243-245, Ernest N. Morial Convention Center
8:30am - 5:00pm

Paul Debevec
UC Berkeley
Leonard McMillan
MIT
Richard Szeliski
Microsoft Research

Michael Cohen
Microsoft Research
Chris Bregler
Stanford University
François Sillion
iMAGIS - GRAVIR/IMAG
Scene with Geometric Detail

Model-Based Stereo

Approximate Block Model
Model-Based Stereo

Given a key and an offset image,

- **Project** the offset image onto the model
- **View** the model through the key camera
  → Warped offset image

Stereo becomes feasible between key and warped offset images because:

- Disparities are small
- Foreshortening is greatly reduced
Synthetic Views of Refined Model

Four images composited with Model-Based Stereo and VDTM
Application: Rouen Revisited
(Golan Levin and Paul Debevec)

www.debevec.org/Rouen

Synthetic View: 1996
Synthetic View: 1896
Synthetic View: Monet Painting
(Uncalibrated Views)
Video
Application: The Campanile Movie

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Cris Benton: Kite Aerial Photography

http://www-archfp.ced.berkeley.edu/kap/
Tower Photographs
Campanile
Model
Environment Photographs
Campus Model (Campanile + 40 buildings)
Terrain Modeling

- Delaunay triangulation of building bases + other recovered ground points
- Extension out to horizon
Video
A view from too far away
Comparison: Time-of-flight Laser Scanning

Laser scan of Berkeley’s Campanile, courtesy of Cyra corporation
Application: The Matrix

George Borshukov, Dan Piponi, Kim Libreri, and John Gaeta, MANEX Entertainment

www.mvfx.com
The Matrix – Reconstruction Stills – EF9
Video
Commercial Product: Metacreations (now Adobe) Canoma

www.metacreations.com/canoma
www.canoma.com
Application: Inverse Global Illumination

Yizhou Yu, Paul Debevec, Jitendra Malik, Tim Hawkins

SIGGRAPH 99

40 radiance maps of a room
Recovered Geometry and Viewpoints
Real/Synthetic Comparison
Same viewpoints, Same lighting, Same objects
Real/Synthetic Comparison
New viewpoint, New lighting, New object
MODELING IN **Fiat Lux**

Paul Debevec, Tim Hawkins, Westley Sarokin, H. P. Duiker, Christine Cheng, Tal Garfinkel, Jenny Huang
Radiance Image Data

Stp1 Panorama
Assembled Panorama
Interior model recovered from panorama

(35 parameters)
Baldacchino Layers
Light Probe Images
Lighting Calculation

“Impostor” light sources

Renderings made with Radiance: http://radsite.lbl.gov/radiance/
Synthetic Objects
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