Modeling and Rendering Architecture from Photographs

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Immersion '94
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Stereo Image Capture
Depth Map
Synthetic Views

The Chevette Project 1991

Modeling and Rendering Architecture from Photographs
(Debevec, Taylor, and Malik 1996)

Brick Model
User-Defined Edges
Recovered Model

Façade
Debevec, Taylor, and Malik
SIGGRAPH '96

Paul Debevec - "Modeling and Rendering Architecture from Photographs" - www.debevec.org
Façade Blocks

Parameterized Block

Model Hierarchy

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.

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.
Modeling with blocks works because:
Convenient for architecture
Recovers Complete Models
Reduces number of model parameters, e.g.
Campanile model has:
- 2,596 parameters as independent edges
- 240 parameters as independent blocks
- 33 parameters as constrained blocks
- Few marked features required
- Easier to solve

Surfaces of Revolution

Arches and Surfaces of Revolution

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

Debevec, Borshukov, and Yu. Eurographics Rendering Workshop 1998
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)
Two Depictive Studies

Synthetic View: 1996
Synthetic View: 1886
Synthetic View: Monet Painting

Application: The Campanile Movie
Paul Debevec, George Borshukov, Victor Yu, Jason
Koare, Vivian Jiang, Chris Wright, Jamie Klosowy, Charles
Benton, Tim Hawkins, Charles Ying

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Cris Benton: Kite Aerial Photography

Video

Cris Benton: Kite Aerial Photography

http://www.archip.ucd.berkeley.edu/kap/

Tower Photographs

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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
Comparison: Time-of-flight Laser Scanning
Laser scan of library's Cupola.
courtesy of Cyra Corporation

Application: The Matrix

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
Yizhao Yu, Paul Debevec, Hiendra Malik, Tim Hawkins
SIGGRAPH ‘99
Recovered Geometry and Viewpoints

Real/Synthetic Comparison
Same scene, same lighting, same object

Real/Synthetic Comparison
New viewpoint, new lighting, new object

Modeling in Flatland

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www.debevec.org

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