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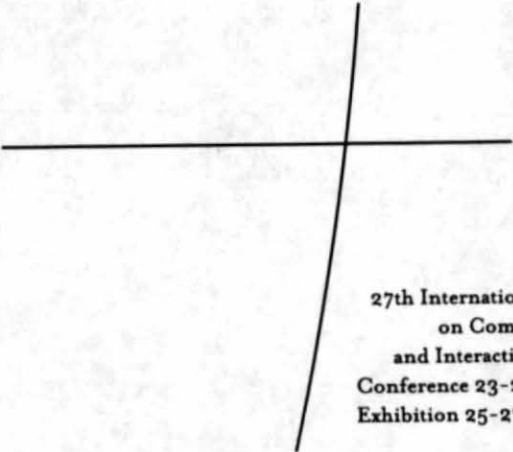
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COURSE NOTES

3D Photography



27th International Conference
on Computer Graphics
and Interactive Techniques
Conference 23-28 July 2000
Exhibition 25-27 July 2000

NEW ORLEANS

SIGGRAPH 2000

Course Syllabus

(Note: these times are tentative and subject to change on the day of the course.)

A. 8:30 - 8:50, 20 min

Introduction (Seitz)

1. Overview of area and the course
2. Acquiring 3D models from images
3. Applications to computer graphics

B. 8:50 - 9:35, 45 min

Sensing for vision and graphics (Nayar)

1. The dimensions of visual sensing
2. Catadioptric vision
3. Panoramic and omnidirectional cameras
4. Spherical mosaics
6. Radiometric self calibration
7. High dynamic range imaging

C. 9:35 - 10:15, 40 min

Overview of passive vision techniques (Seitz)

1. Cues for 3D inference (parallax, shading, focus, texture)
2. Camera Calibration
3. Single view techniques
4. Multiple view techniques
 - Stereo
 - Structure from motion
 - Photometric stereo
5. Strengths and Limitations

<> 10:15 - 10:30 **Break**

D. 10:30 - 11:20, 50 min

Façade: modeling architectural scenes (Debevec)

1. Constrained structure recovery
 - Architectural primitives
2. Photogrammetry
 - Recovering camera parameters
 - Importance of user-interaction
3. Model-based stereo
4. Connections to image-based rendering
 - Impact of geometric accuracy on rendering quality
 - Local vs. global 3D models

E. 11:20 - 12:00, 40 min

Voxels from images (Seltz)

1. Voxel-based scene representation
2. Volume intersection
 - Shape from silhouettes
3. Voxel coloring
 - Modeling radiance
 - Plane-sweep visibility
4. Space carving
 - General visibility modeling
 - Ambiguities in scene reconstruction
5. Related Techniques

<> 12:00 - 1:30 Lunch

F. 1:30 - 2:10, 40 min

Overview of active vision techniques (Curless)

1. Imaging radar
 - Time of flight
 - Amplitude modulation
2. Optical triangulation
 - Scanning with points and stripes
 - Spacetime analysis
3. Interferometry
 - Moire
4. Structured light applied to passive vision
 - Stereo
 - Depth from defocus
5. Reflectance capture
 - From shape-directed lighting
 - Using additional lighting

G. 2:10 - 2:50, 40 min

Desktop 3D Photography (Bouguet)

1. Traditional scanning is expensive, but...
desk lamp + pencil = structured light
2. Geometry of shadow scanning
 - Indoor: on the desktop
 - Outdoor: the sun as structured light
3. Image processing: Spacetime analysis for better accuracies
4. Calibration issues
 - Camera calibration
 - Light source calibration
5. Experimental results (indoor and outdoor)
6. Error analysis and Real-time implementation

H. 2:50 - 3:35, 45 min

Shape and appearance from images and range data (Curless)

1. Registration
2. Reconstruction from point clouds
3. Reconstruction from range images
 - Zippering
 - Volumetric merging
4. Modeling appearance

<> 3:35 - 3:50 **Break**

I. 3:50 – 5:00, 70 min

Application: The Digital Michelangelo Project (Levoy)

1. Scholarly and commercial motivations
2. Hardware and software
3. Scanning the David
4. Acquiring a big light field
5. Implications of 3D scanning
6. Lessons learned from the project
7. The problem of the Forma Urbis Romae

<> **Adjourn**

Contents

1. Introduction (Steve Seitz and Brian Curless)

Abstract

2. Acquiring images (Brian Curless)

Slides

3. Unconventional vision sensors (Shree Nayar)

Slides

4. Overview of passive vision techniques (Steve Seitz)

Slides

Papers

A Multiple-Baseline Stereo

M. Okutomi and T. Kanade

Single View Metrology

A. Criminisi, I. Reid, and A. Zisserman

Paper (printed only)

Shape and Motion from Image Streams under Orthography: A Factorization Method

C. Tomasi and T. Kanade

5. Camera calibration (Steve Seitz)

Slides

6. Voxels from images (Steve Seitz)

Slides

Papers

Photorealistic Scene Reconstruction by Voxel Coloring

S. M. Seitz and C. R. Dyer

A Theory of Shape by Space Carving

K. N. Kutulakos and S. M. Seitz

7. Façade: modeling architectural scenes (Paul Debevec)

Introduction

Slides

Papers

Modeling and Rendering Architecture from Photographs: A Hybrid Geometry- and Image-Based Approach

P. E. Debevec, C. J. Taylor, and J. Malik

Recovering Arches in Facade using Ray-Plane Intersections in 3D

G. D. Borshukov and P. Debevec

Recovering the Radius and Offset of a Cross-Section in SORs Using Minimum Distance between Two Rays in 3-D.

G.D. Borshukov and P. Debevec

Videos (on CDROM only)

The Chevette Project

Immersion 1994

Berkeley Campus Model

8. Overview of active vision techniques (Brian Curless)

Slides

Paper

Better Optical Triangulation through Spacetime Analysis

B. Curless and M. Levoy

9. Desktop 3D photography (Jean-Yves Bouguet)

Slides

Papers

3D Photography on Your Desk

J. Y. Bouguet and P. Perona

3D Photography Using Shadows in Dual-space Geometry

J. Y. Bouguet and P. Perona

VRML models (on CDROM only)

10. Shape and appearance from images and range data (Brian Curless)

Slides

Papers

Surface Reconstruction from Unorganized Points

H. Hoppe, T. DeRose, and T. Duchamp

Mesh Optimization

H. Hoppe, T. DeRose, T. Duchamp, J. McDonald, and W. Stuetzle

Zippered Polygon Meshes from Range Images

G. Turk and M. Levoy

A Volumetric Method for Building Complex Models from Range Images

B. Curless and M. Levoy

11. Application: The Digital Michelangelo Project (Marc Levoy)

Slides

Bibliography of papers included in this volume

- C. Tomasi and T. Kanade, *Shape and Motion from Image Streams under Orthography: A Factorization Method*, International Journal of Computer Vision, Vol. 9, No. 2, 1992, pp. 137-154.
- M. Okutomi and T. Kanade, *A Multiple-Baseline Stereo*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 15, No. 4, 1993, pp. 353-363.
- A. Criminisi, I. Reid, and A. Zisserman, *Single View Metrology*, Proc. 7th International Conference on Computer Vision, pp. 434-442, 1999.
- S. M. Seitz and C.R. Dyer, *Photorealistic Scene Reconstruction by Voxel Coloring*, Proc. IEEE Conf. on Computer Vision and Pattern Recognition, 1997, pp. 1067-1073.
- K. N. Kutulakos and S. M. Seitz, *A Theory of Shape by Space Carving*, International Journal of Computer Vision, 2000, to appear.
- P. E. Debevec, C. J. Taylor, and J. Malik, *Modeling and Rendering Architecture from Photographs: A Hybrid Geometry- and Image-Based Approach*, Proc. ACM SIGGRAPH 96, 1996, pp. 11-20.
- G.D. Borshukov and P. Debevec, *Recovering Arches in Façade Using Ray-Plane Intersections in 3-D*.
- G.D. Borshukov and P. Debevec, *Recovering the Radius and Offset of a Cross-Section in SORs Using Minimum Distance between Two Rays in 3-D*.
- B. Curless and M. Levoy, *Better Optical Triangulation through Spacetime Analysis*, IEEE International Conference on Computer Vision, 1995, pp. 987-994.
- J. Y. Bouguet and P. Perona, *3D photography on your desk*, Proc. IEEE International Conference on Computer Vision, 1998, pp. 43-50.
- J. Y. Bouguet and P. Perona, *3D Photography Using Shadows in Dual-space Geometry*, International Journal of Computer Vision, Vol. 35, No. 2, Nov./Dec. 1999, pp. 129-149.
- G. Turk and M. Levoy, *Zippered Polygon Meshes from Range Images*, Proc. ACM SIGGRAPH 94, 1994, pp. 311-318.
- H. Hoppe, T. DeRose, and T. Duchamp, *Surface Reconstruction from Unorganized Points*, Proc. ACM SIGGRAPH 92, 1992, pp. 71-78.
- H. Hoppe, T. DeRose, T. Duchamp, J. McDonald, and W. Stuetzle, *Mesh Optimization*, Proc. ACM SIGGRAPH 93, 1993, pp. 19-26.
- B. Curless and M. Levoy, *A Volumetric Method for Building Complex Models from Range Images*, Proc. ACM SIGGRAPH 96, 1996, pp. 303-312.