Interactive Scene Modeling from Dense Color and Sparse Depth

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Scene Modeling

• Most scenes cannot be captured using single view

Acquire
Register
Model
Inspect & Adjust

Challenge: Let the user inspect the results and adjust the scanning interactively

Rusinkiewicz S., Real-Time 3D Model Acquisition. Proc. SIGGRAPH 2002
Acquisition

• Need to acquire color and depth samples
• Color acquisition: solved
• Approaches for depth acquisition
  – No depth (Quicktime VR, light fields)
  – Coarse, manual depth (Façade, view morphing)
  – Dense depth (stereo, structured light, time of flight)
Model Camera: dense color and **sparse depth**

- Video camera ($1,500)
- Laser module ($1,000)
- 7x7 laser dot pattern
Depth Acquisition

Fast
- Epipolar geometry
- Coherence

Accuracy:
3 mm at 1m
12 mm at 2m

depthExtraction.avi
Structured scenes

• A few smooth surfaces per frame, that can be approximated polynomially
Structured scene modeling

1. Freehand acquisition
Structured scene modeling

1. Freehand acquisition
2. Depth extraction
Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
4. Registration
   • Depth then color registration
Structured scene modeling

1. Freehand acquisition
2. Depth extraction
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Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
4. Registration
5. Modeling
Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
4. Registration
5. Modeling
6. Visualization

freehandModeling.avi
Unstructured scenes

- Surface between dots cannot be approximated well
Unstructured scenes

• Use parallax-free pan-tilt head
  – Registration using color only
Unstructured scene modeling

1. Tripod acquisition
Unstructured scene modeling

1. Tripod acquisition
2. Registration
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   • Depth extraction
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   • Depth extraction
   • 2D triangulation
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   - Depth extraction
   - 2D triangulation
   - 3D mesh
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   - Depth extraction
   - 2D triangulation
   - 3D mesh
4. Visualization
   - 3D mesh
Unstructured scene modeling

1. Tripod acquisition
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Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   • Depth extraction
   • 2D triangulation
   • 3D mesh
4. Visualization
   • 3D mesh
   • splatting
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   - Depth extraction
   - 2D triangulation
   - 3D mesh
4. Visualization
   - 3D mesh
   - splatting
Depth Enhanced Panoramas

- Allow viewpoint translation away from the acquisition point
- Still inexpensive and quick to acquire using ModelCamera

Show panorama vs DEP video
Discussion

• Cheap and portable device
• Acquires color and depth information simultaneously
• The evolving model is constantly presented to the operator
• The operator guides the scanning process
• Fast acquisition (15 minutes for 200,000 vertices)
Future Work

- Registration drift in freehand mode
- Registration based on sparse geometry only
- Merging multiple depth enhanced panoramas
- Scanning entire building in a single day (in parallel)

www.cs.purdue.edu/cgvlab/modelCamera
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