Interactive Scene Modeling from Dense Color and Sparse Depth

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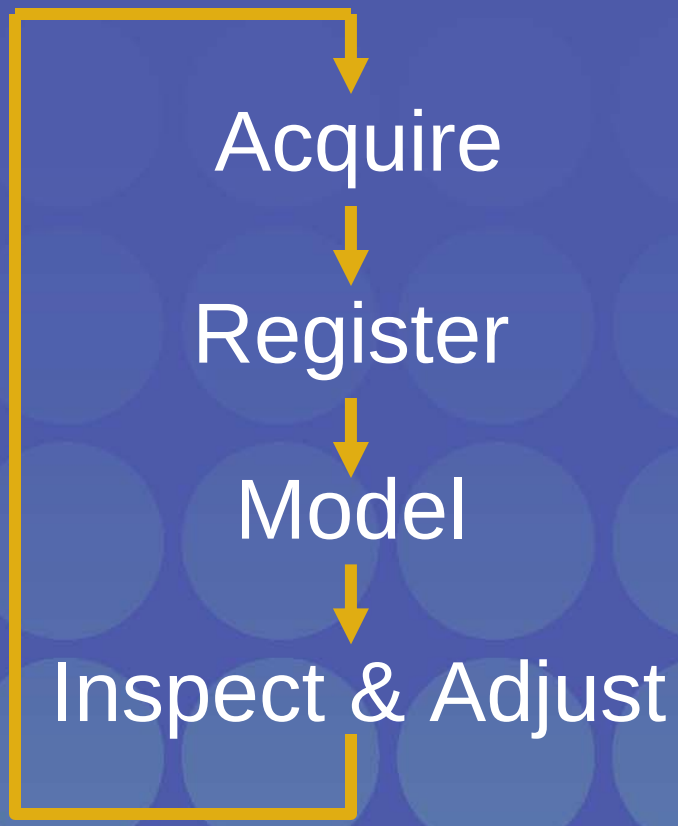
Scene Modeling

- Most scenes cannot be captured using single view



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)

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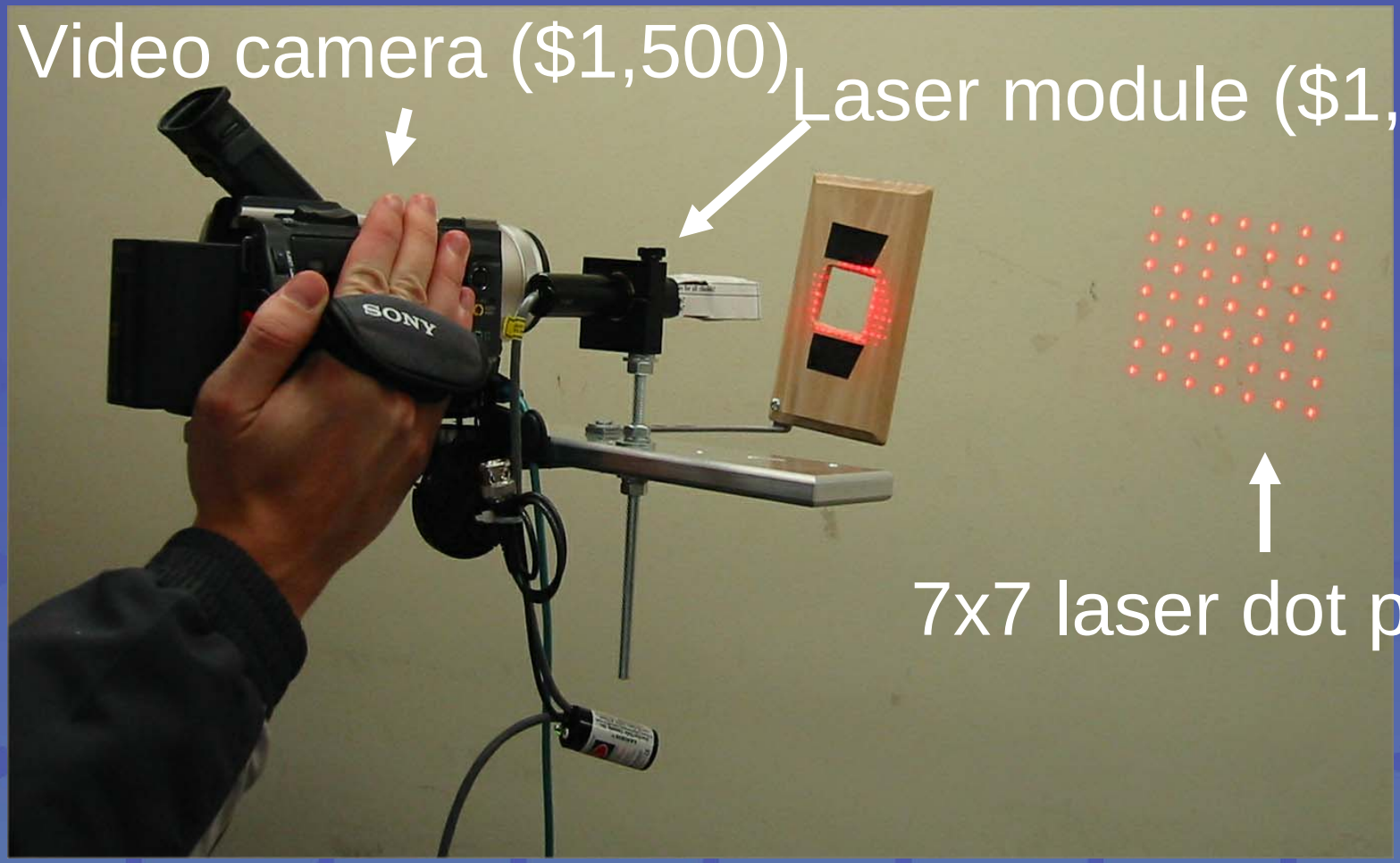
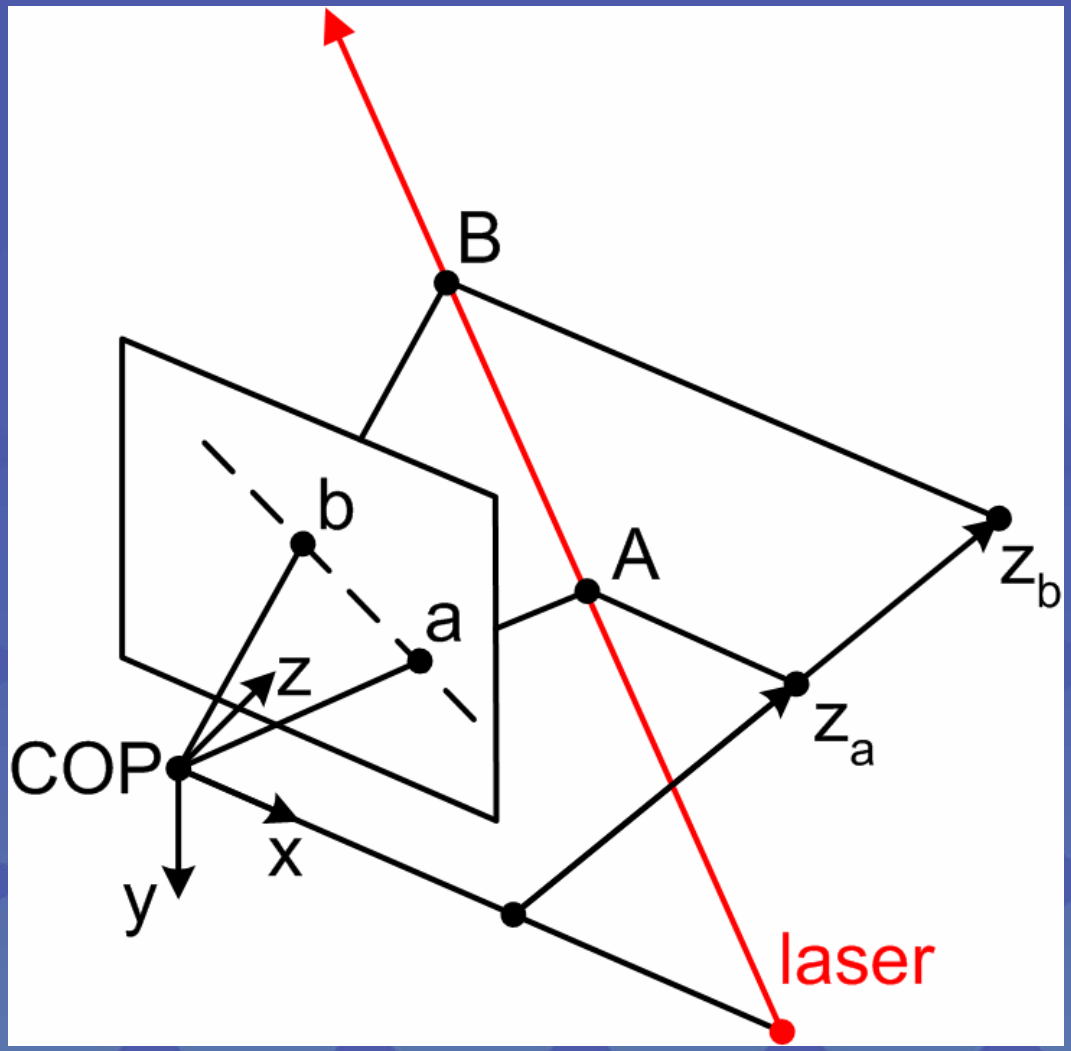
ModelCamera: dense color and *sparse depth*



Depth Acquisition



Fast

- Epipolar geometry
- Coherence

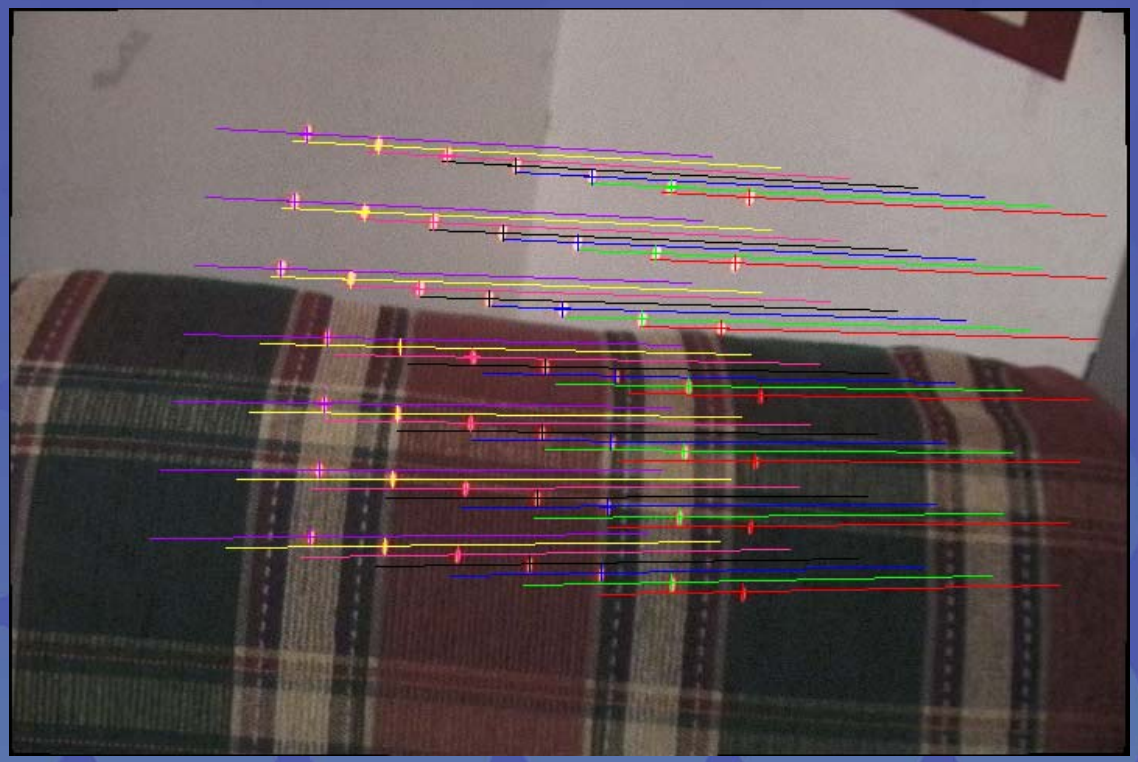
depthExtraction.avi

Accuracy:

3 mm at 1m

12 mm at 2m

Structured scenes



- A few smooth surfaces per frame, that can be approximated polynomially

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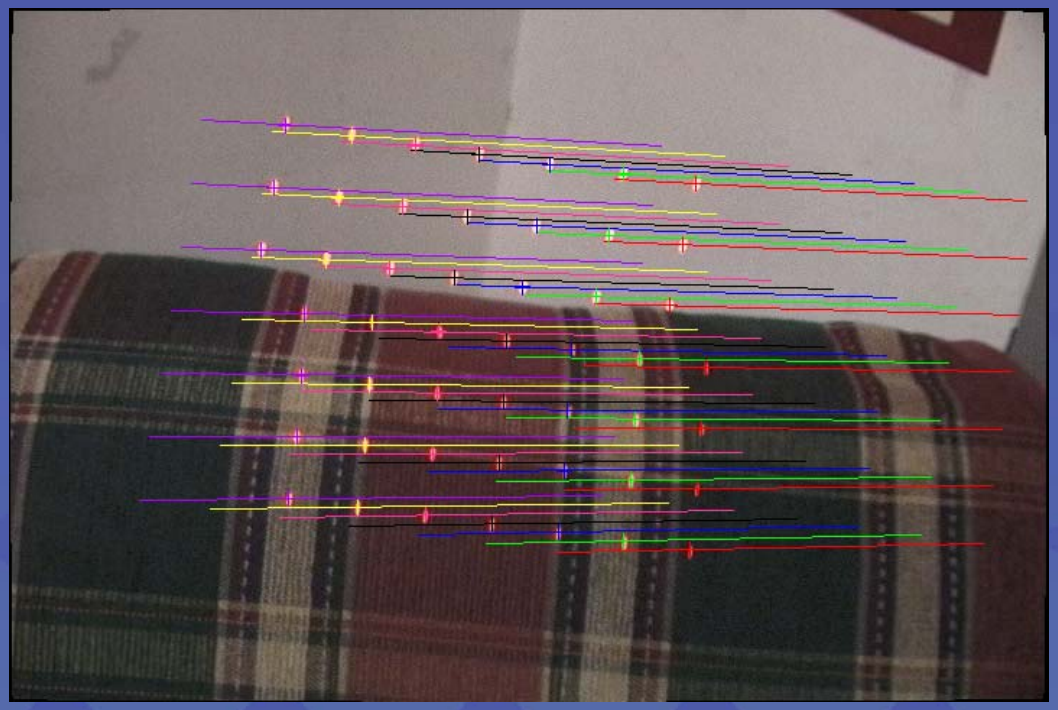
Structured scene modeling

1. Freehand acquisition

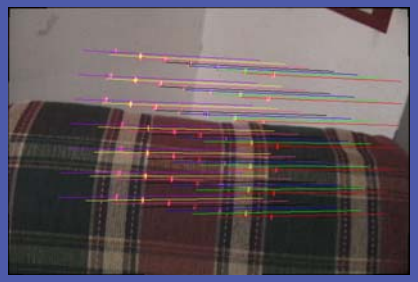
Structured scene modeling

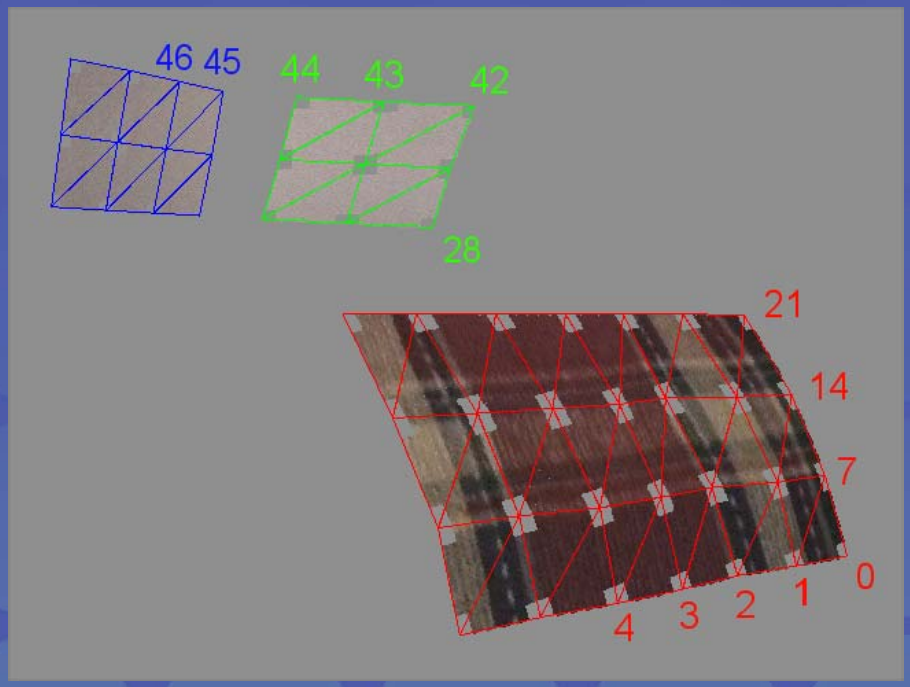


1. Freehand acquisition
2. Depth extraction

Structured scene modeling

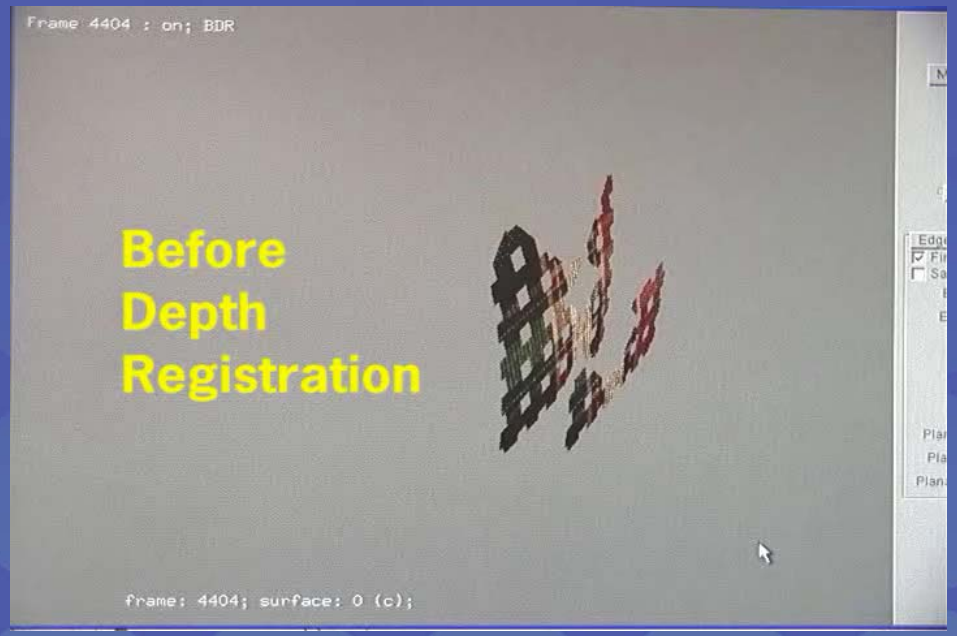
1. Freehand acquisition
2. Depth extraction
3. Surface identification





Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
4. Registration
   - Depth then color registration



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Structured scene modeling

1. Freehand acquisition
2. Depth extraction
3. Surface identification
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   - Depth then color registration

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Structured scene modeling

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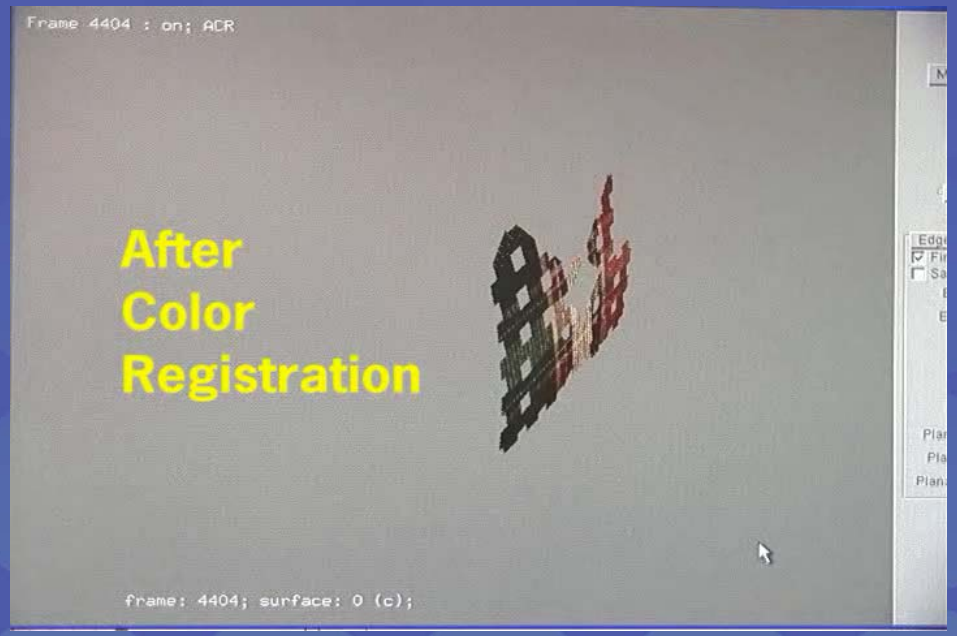

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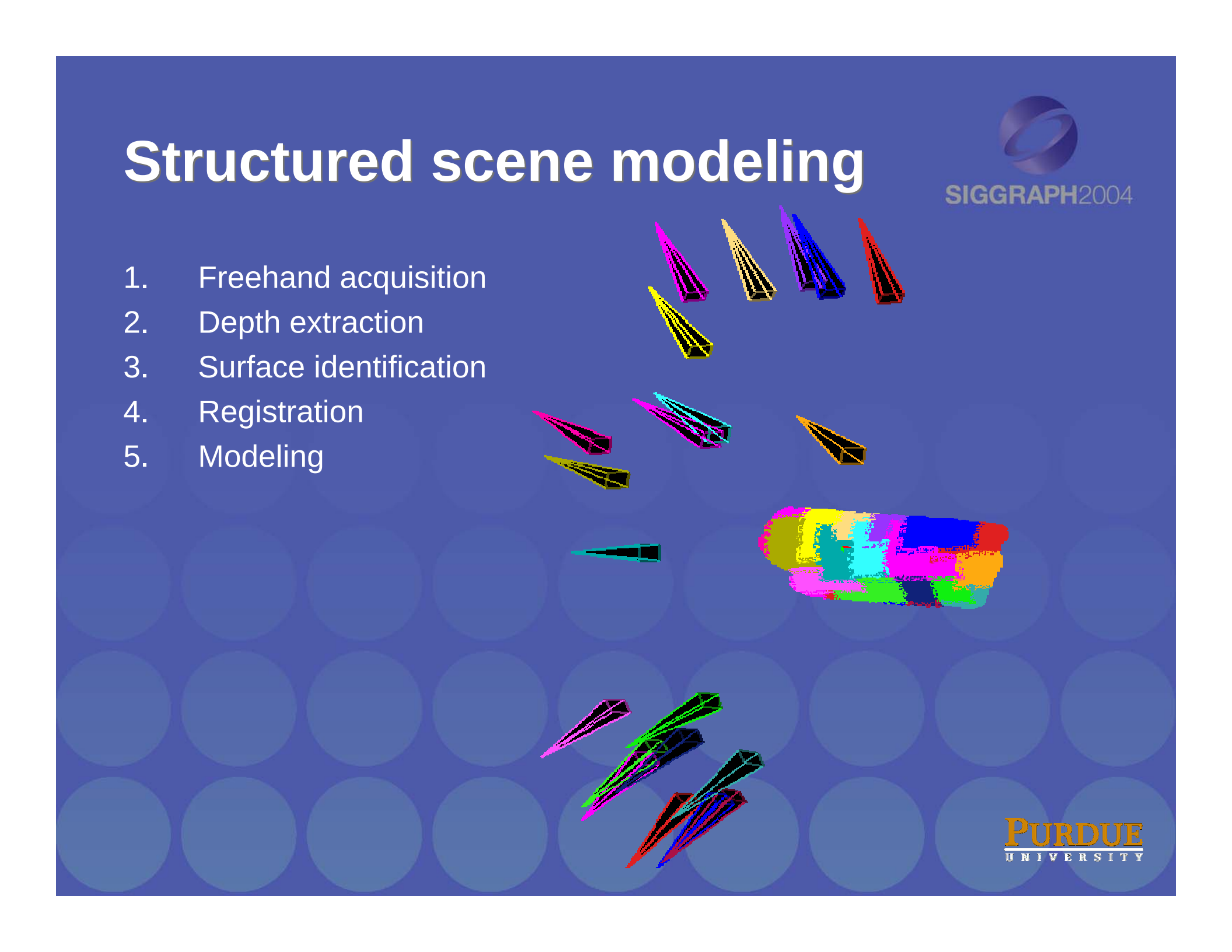
Structured scene modeling



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

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- Use parallax-free pan-tilt head
  - Registration using color only

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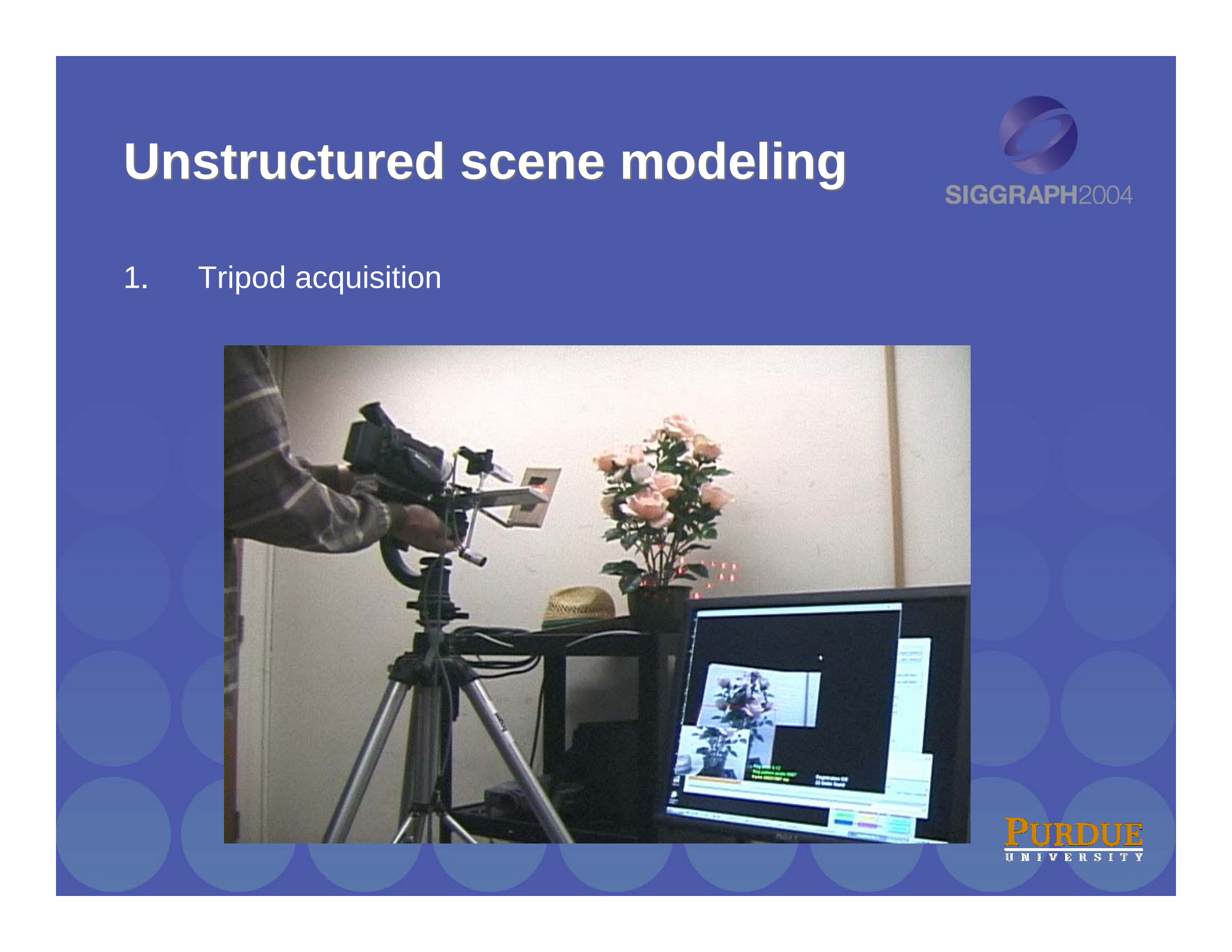
Unstructured scene modeling



1. Tripod acquisition

Unstructured scene modeling

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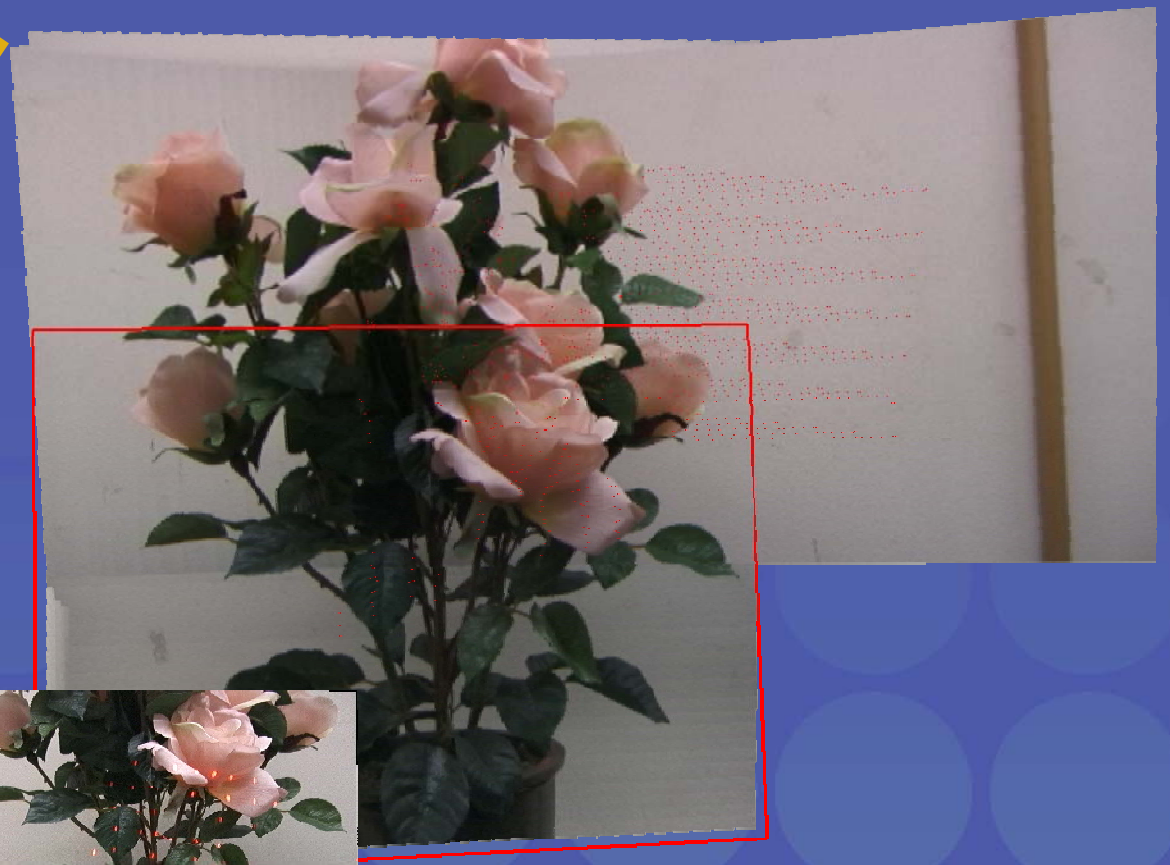
1. Tripod acquisition
2. Registration



Reg error 4.01
Reg pattern pixels 5511
frame 00031532 ms

Registration OK
24 blobs found

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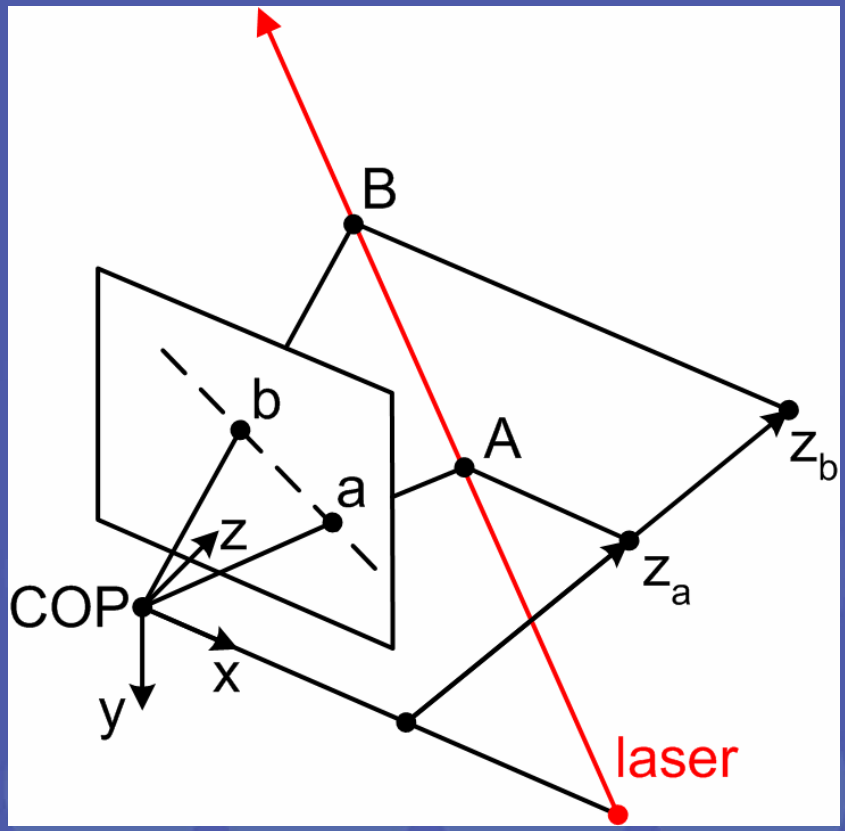
Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   - Depth extraction



Unstructured scene modeling

1. Tripod acquisition
2. Registration
3. Modeling
   - Depth extraction
   - 2D triangulation

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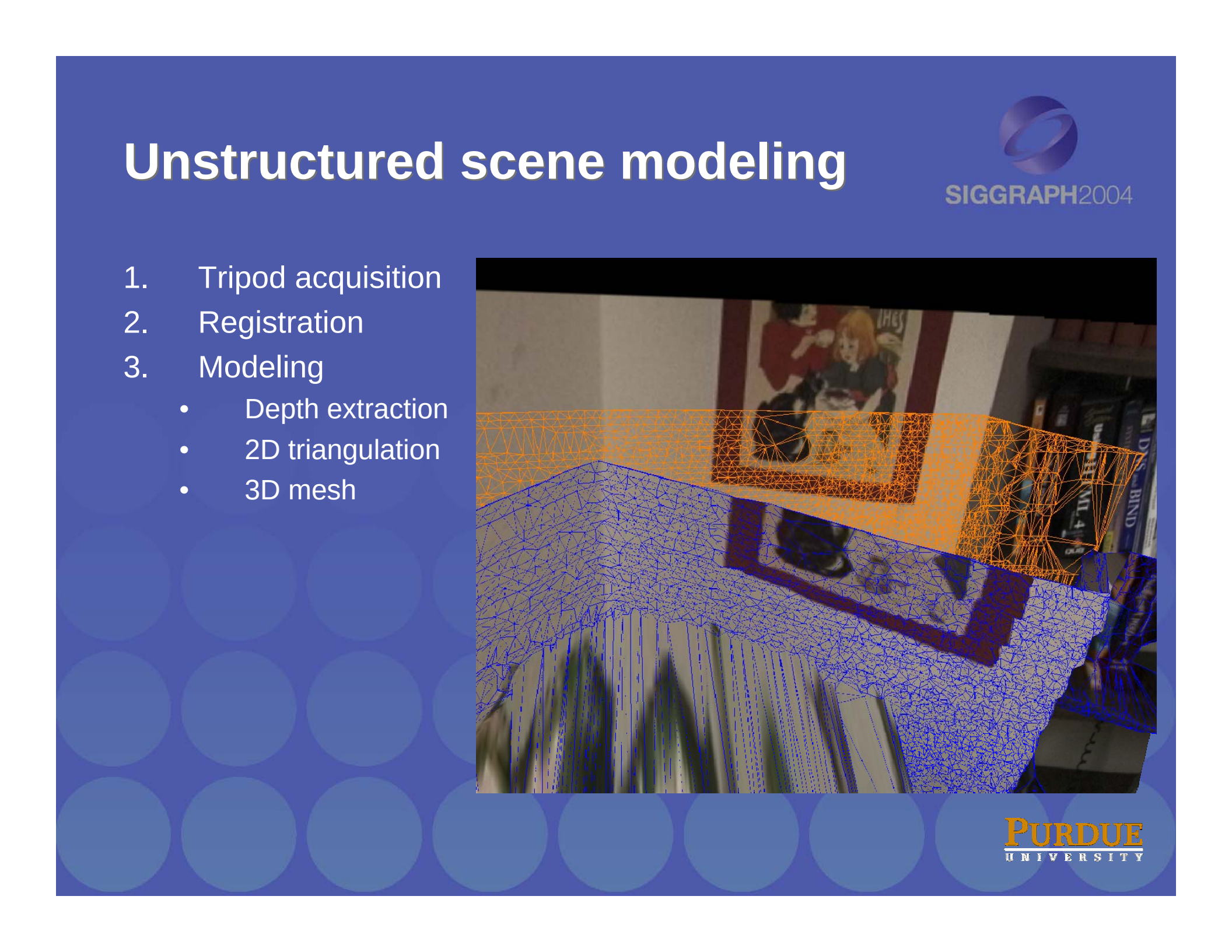
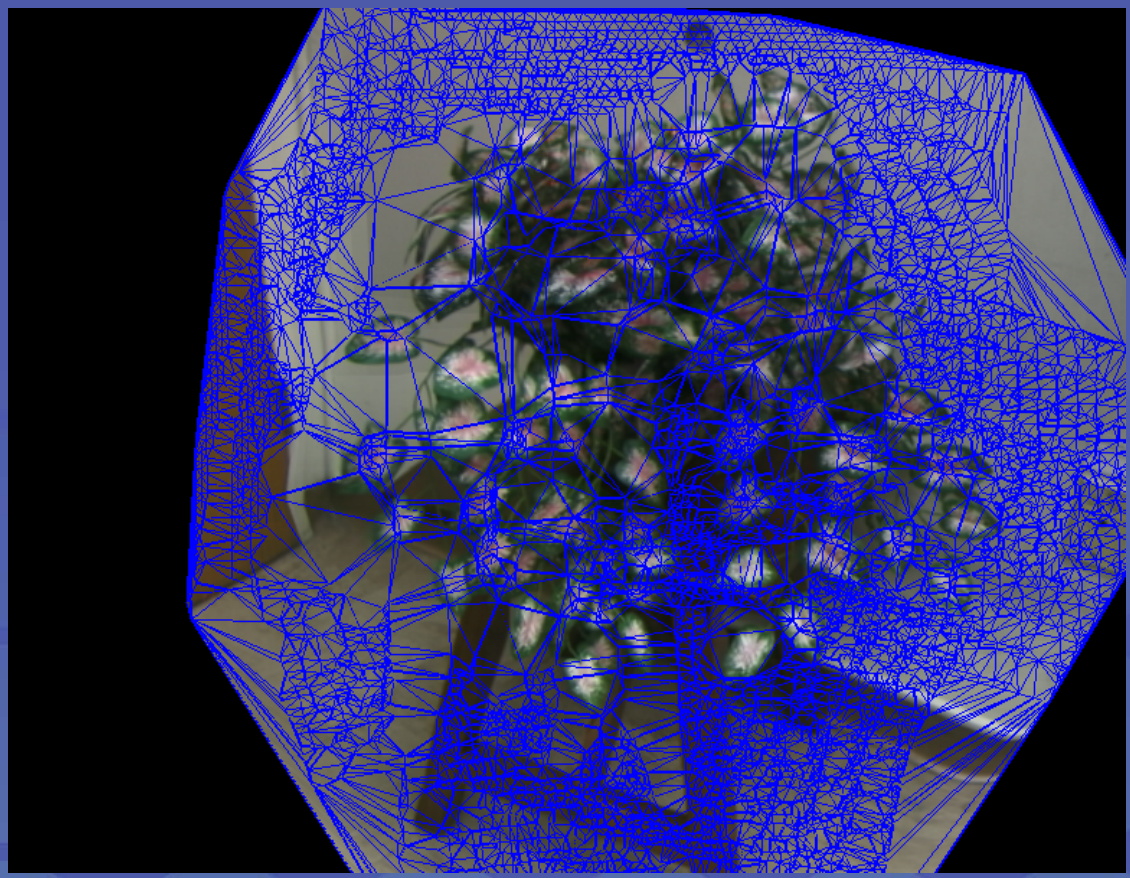
Unstructured scene modeling



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

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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
2. Registration
3. Modeling
   - Depth extraction
   - 2D triangulation
   - 3D mesh
4. Visualization
   - 3D mesh

Unstructured scene modeling

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

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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

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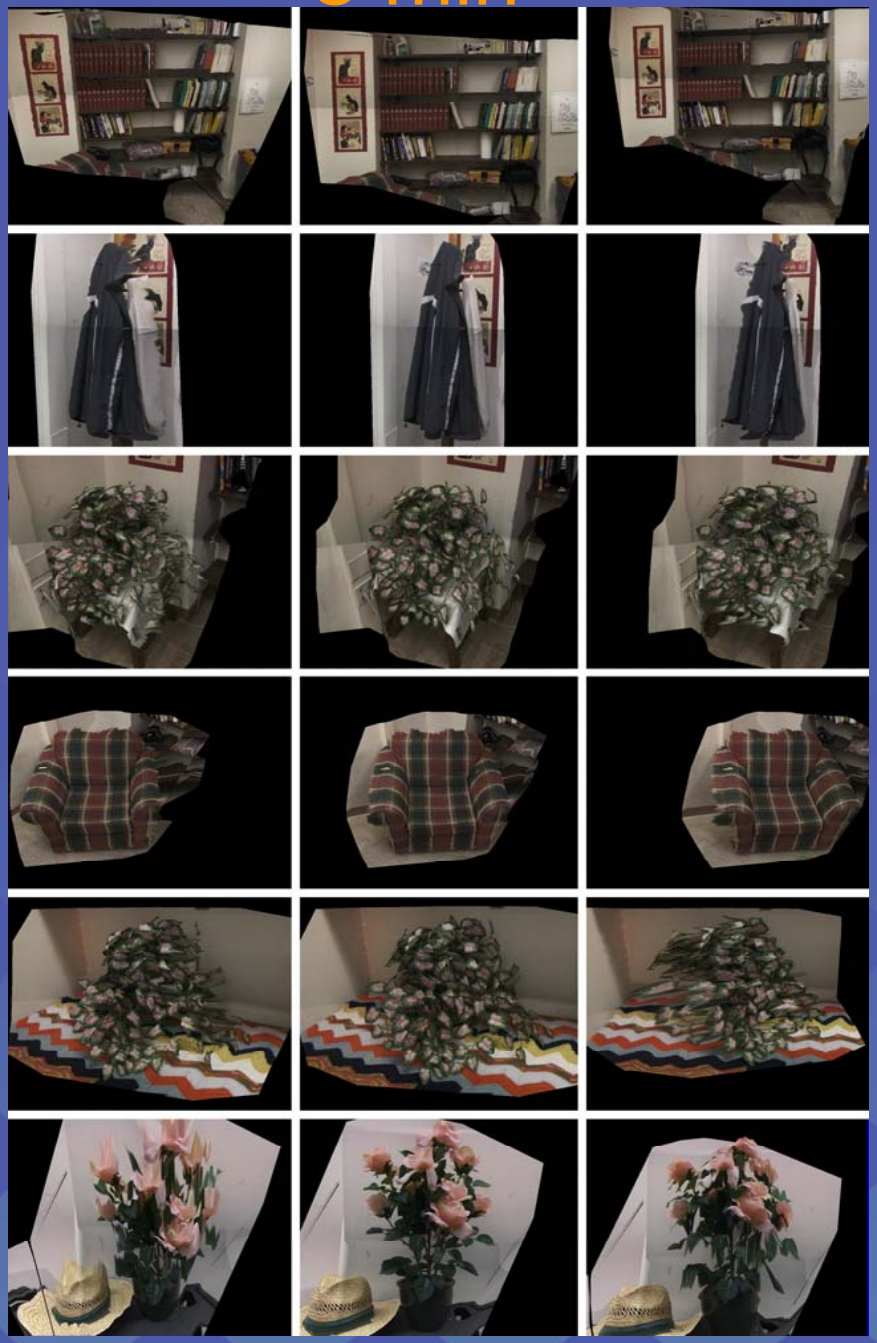
5 min



20 min

Depth Enhanced Panoramas

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

Show panorama vs DEP video

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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)

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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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Acknowledgments

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Chun Jia – initial stitching implementation

Mihai Mudure – edge processing code

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