Interactive Acquisition of Residential Floor Plans

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Residential Floor Plans

• Lucky: Blue print
• Ordinary person: Measuring tape & sketch
• Expert: Point to point laser device & sketch
• Interactive hand-held system
  – Microsoft Kinect
  – Projector
  – Input button
Interactivity

[Mistry et al 2009]
Algorithm

Initialization → Pair-wise registration → Plane extraction → Success → Global adjustment

Success → Map update

Failure → Adjust data path

User interaction

Visual feedback

Fetch a new frame

Exists → Global adjustment

New → Map update

Left click → Select planes

Right click → Start a new room
Pair-wise registration

• Transformation between two consecutive frames
Pair-wise registration

• Transformation between two consecutive frames

**Image features** recover displacement parallel to the image plane

**Depth measurements** recover displacement along the ray direction
Registration failure
Global Adjustment

\[ y \times \Delta x = a \Delta 2 x = b x = c \]
Global Adjustment

\( x = a \)

\( x = c \)

\( x = b \)

\( \Delta_1 \)

\( \Delta_2 \)

\( a = c \)
Global Adjustment

\[
\min_{S^x} \sum_{i} \left( \frac{\|\Delta_i - m_i\|^2}{\sigma_i^2} \right) \quad \text{s.t.} \quad c_{j1} = c_{j2}, \quad \forall (c_{j1}, c_{j2}) \in C^x
\]
Selecting components
Selecting components
Floor plan generation
Floor plan generation
## Result

<table>
<thead>
<tr>
<th>Data set</th>
<th>No. of frames</th>
<th>Run time</th>
<th>Fps</th>
<th>Average error</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>m</td>
</tr>
<tr>
<td>1</td>
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<td>2m 56s</td>
<td>8.32</td>
<td>0.115</td>
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<tr>
<td>2</td>
<td>1009</td>
<td>1m 57s</td>
<td>8.66</td>
<td>0.064</td>
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<tr>
<td>3</td>
<td>2830</td>
<td>5m 19s</td>
<td>8.88</td>
<td>0.053</td>
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<tr>
<td>4</td>
<td>1129</td>
<td>2m 39s</td>
<td>7.08</td>
<td>0.088</td>
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<td>6.59</td>
<td>0.178</td>
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<tr>
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<td>2811</td>
<td>7m 4s</td>
<td>6.65</td>
<td>0.096</td>
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<tr>
<td>Average</td>
<td>1795</td>
<td>3m 57s</td>
<td>7.54</td>
<td>0.075</td>
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**2-5 minutes** to initiate, run, and generate floor plan

(10-20 minutes for laser measurements)
## Result

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**Average**

- **No. of frames**: 1795
- **Run time**: 3m 57s
- **Fps**: 7.5
- **Average error**: 0.075
- **Average error**: 2.86

**Average error breakdown**

- **data i/o**: 58.672 (51%)
- **prepare image**: 0.104 (0%)
- **optical flow**: 13.203 (12%)
- **pair-wise registration**: 11.845 (10%)
- **plane extraction**: 3.318 (3%)
- **data association**: 5.797 (5%)
- **refine registration**: 6.728 (6%)
- **optimize map**: 14.517 (13%)
- **7.5 fps** on an Intel 2.50GHz Dual Core laptop
Conclusion

• We present a practical system to acquire residential floor plans and allow augmented reality.
• The hand-held system is composed of a commodity depth sensor (Microsoft Kinect) and a projector.
• During the process, the projector displays the status of reconstruction on the physical surface scanned.
• From the projection, the user can intuitively sense errors and provide high-level correction if necessary.
Thank you