Modeling 3D Urban Spaces Using Procedural and Simulation-Based Techniques

Image-Based Buildings and Facades (Part 2)

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Reconstruction from a single orthographic image

• **Image-based Façade Modeling**
  J. Xiao, T. Fang, P. Tan, P. Zhao, E. Ofek, L. Quan
  SIGGRAPH ASIA 2008
Outline: Façade initialization

1. Optional Input Approximate Model
2. Initial Flat Facade
3. Composite Texture Image
4. Facade Decomposition
5. Depth Map
6. Geometry Model
7. Textured Facade
8. 3D Building Model
Outline: Façade initialization
Outline: Façade decomposition

Initial Flat Facade → Composite Texture Image → Facade Decomposition → Depth Map → Geometry Model → Textured Facade

Optional Input Approximate Model → Input Images → 3D Points → 3D Building Model
Outline: Façade augmentation

- Initial Flat Facade
- Composite Texture Image
- Facade Decomposition
- Depth Map
- Geometry Model
- Textured Facade
- Optional Input Approximate Model
- Input Images
- 3D Points
- 3D Building Model
Outline: Façade completion

Initial Flat Facade → Composite Texture Image → Facade Decomposition → Depth Map → Geometry Model → Textured Facade

Optional Input Approximate Model → Input Images → 3D Points → 3D Building Model
Outline: Façade completion

1. Initial Flat Facade
2. Composite Texture Image
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7. Optional Input Approximate Model
8. Input Images
9. 3D Points
10. 3D Building Model
Façade Examples
Dishifu Road @ Canton
Reconstruction from a single image using symmetry

- Symmetric Architecture Modeling with a single image
  Jiang, Tan, Cheong
  SIGGRAPH ASIA 2009
Reconstruction from Lidar

- **SmartBoxes for Interactive Urban Reconstruction**
  Nan, Sharf, Zhang, Cohen-Or, Chen
  SIGGRAPH 2010
Imperfect Scans - Occlusions

• Point cloud contains holes due to various occlusions ("shadows")
Imperfect Scans – Angle & Range

- Oblique scanning angle
- Laser energy attenuation on range
SmartBoxes

- Box-up and Smart!
SmartBoxes

- **Box** prior shape fitting
- **Smart** context awareness
Preprocessing

• Automatic detection of plane and edges assuming dominant orthogonal axes
  – RANSAC planes
  – Line sweep edges
Snapping a Box

• 2D rubber band ROI
• Collect planes, edges, corners
• Find the best fitting box using data fitting force $D(B,P)$
Grouping

- Simple SmartBox ➔ Compound SmartBox
- Align to remove gaps and intersections
  – cluster and align close to co-linear edges
Drag-and-drop context $C(B_{i-1}, B_i)$

- The context of $B_i$

\[
C(B_{i-1}, B_i) = I(B_{i-1}, B_i) + A(B_{i-1}, B_i) + S(B_{i-1}, B_i)
\]

Interval Alignment Scale
Drag-and-drop context $C(B_{i-1}, B_i)$

- The context of $B_i$
  - Interval term

$$I(B_{i-1}, B_i) = \|\text{center}(B) - \text{center}(B_{i-1})\| - \|\text{center}(B_{i-2}) - \text{center}(B_{i-1})\|$$
Drag-and-drop context $C(B_{i-1}, B_i)$

• The context of $B_i$
  – Alignment term

$$A(B_{i-1}, B_i) = \sum_{e' \in B_{i-1} \& e \in B_{i-1} \text{ correspond}} \|l_{ext}(e') - l_{ext}(e)\|_2$$
Drag-and-drop context $C(B_{i-1}, B_i)$

- The context of $B_i$
  - Scale term

$$S(B_{i-1}, B_i) = \max\left( \frac{\text{diag}(B_{i-1})}{\text{diag}(B_i)}, \frac{\text{diag}(B_i)}{\text{diag}(B_{i-1})} \right)$$
Results: textured buildings
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Results: textured buildings
Reconstruction from Multiple Images

- Interactive 3D Architectural Modeling from Unordered Photo
  Sinha, Steedly, Szeliski, Agrawala
  SIGGRAPH ASIA 2008
Reconstruction from Multiple Images
Reconstruction from Multiple Images

Interactive 3D Architectural Modeling from Unordered Photo Collections
Paper # 0062
Thank You