



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

Image-Based Buildings and Facades (Part 2)

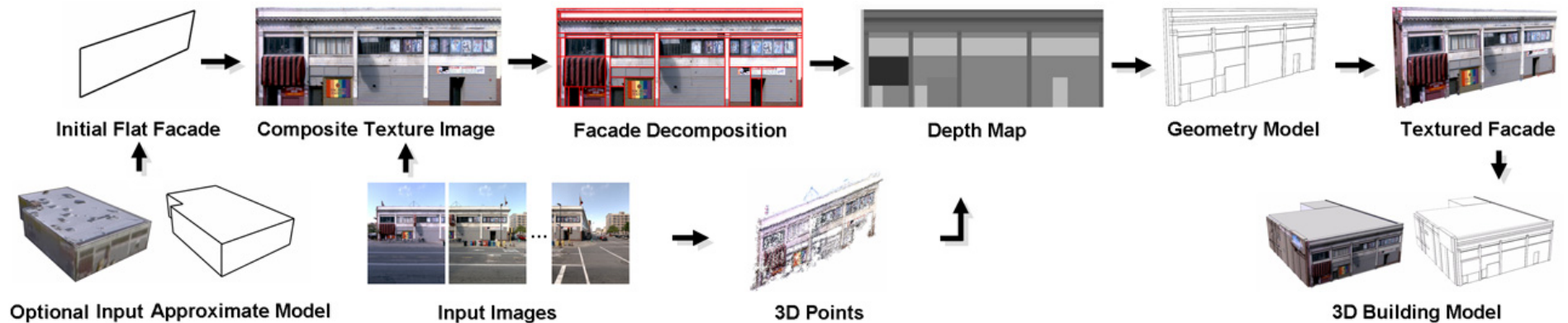
Peter Wonka

Arizona State University

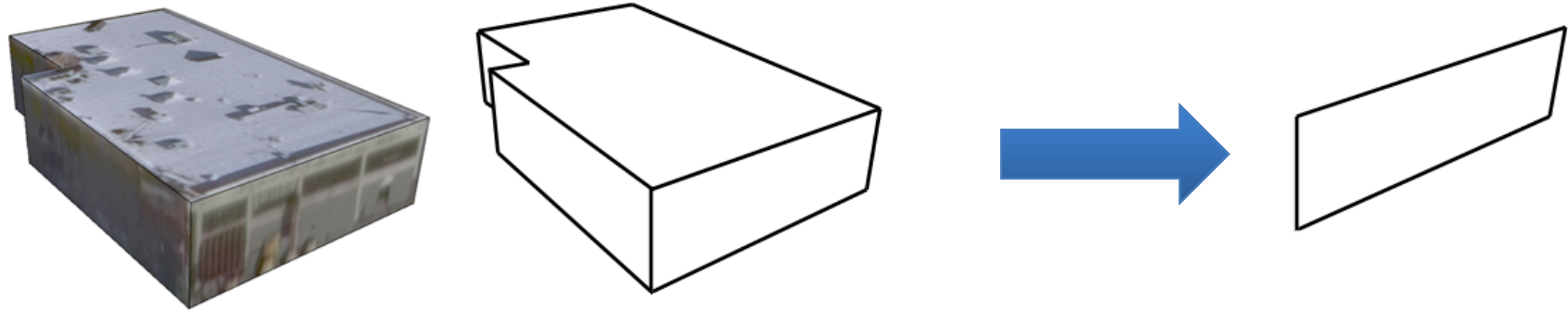
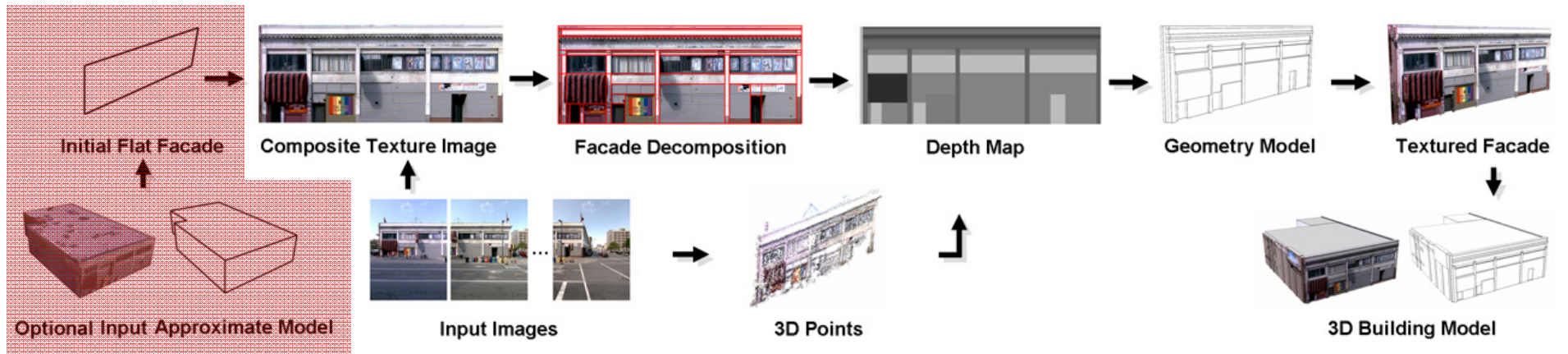
Reconstruction from a single orthographic image

- **Image-based Façade Modeling**

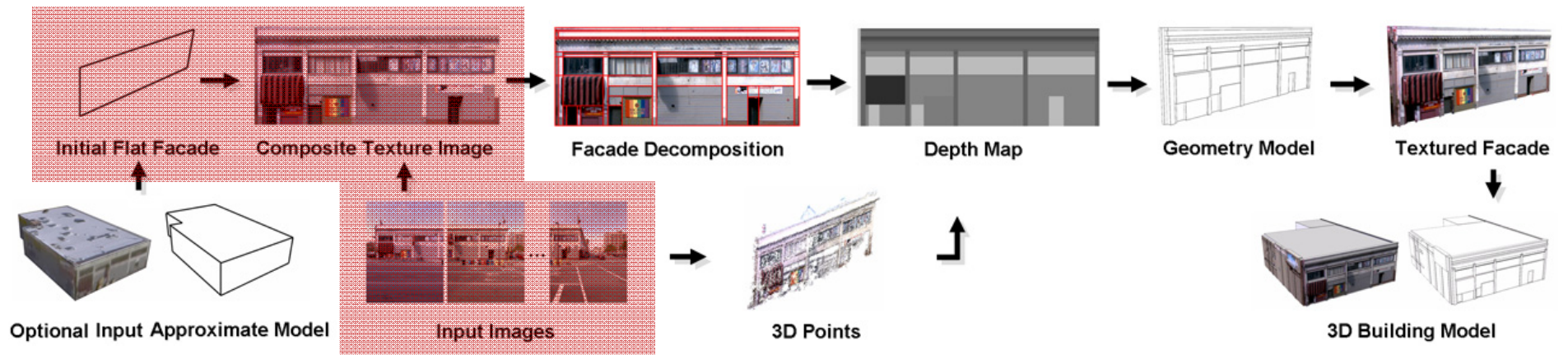
J. Xiao, T. Fang, P. Tan, P. Zhao, E. Ofek, L. Quan
SIGGRAPH ASIA 2008



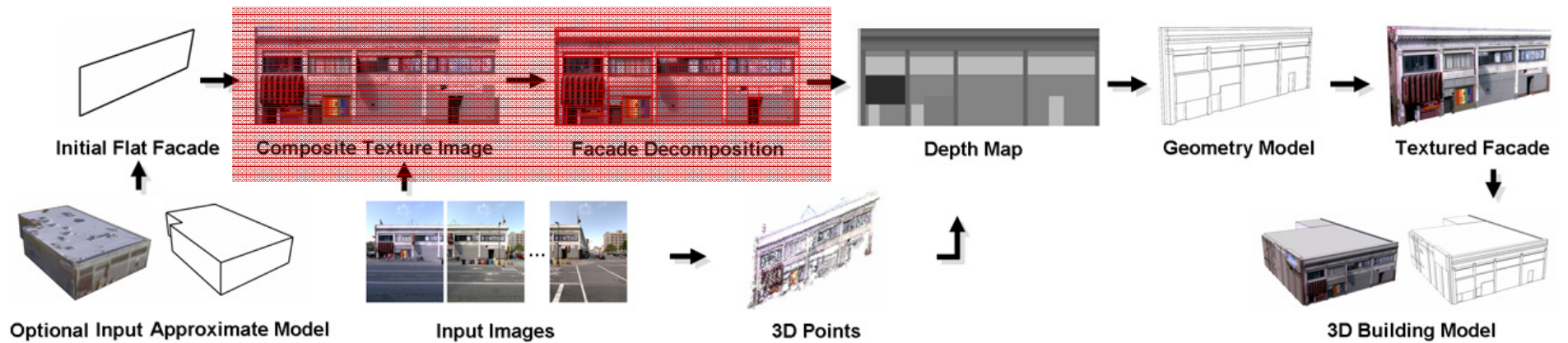
Outline: Façade initialization



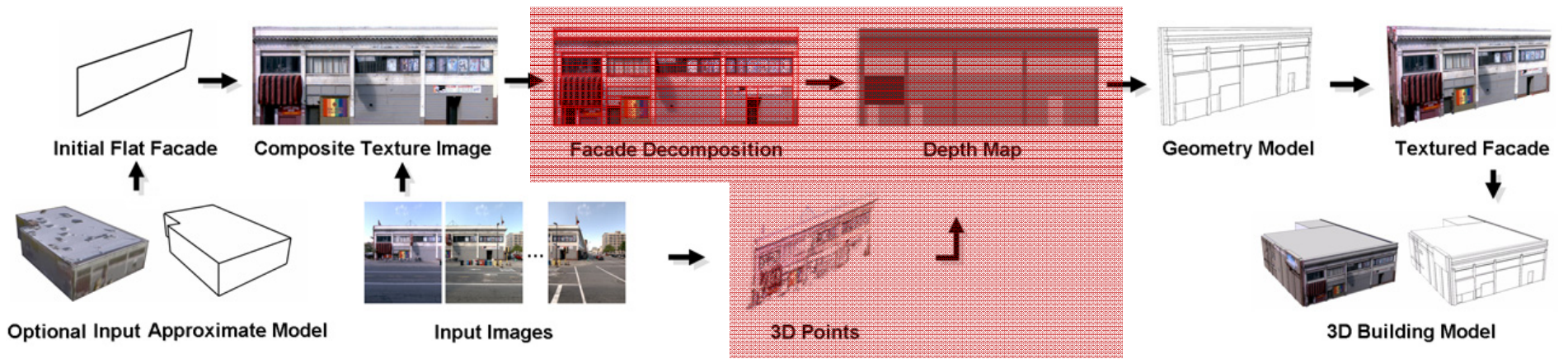
Outline: Façade initialization



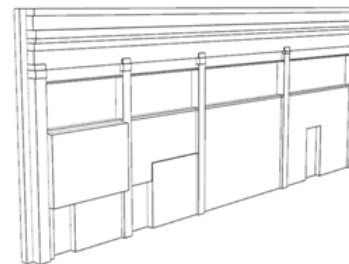
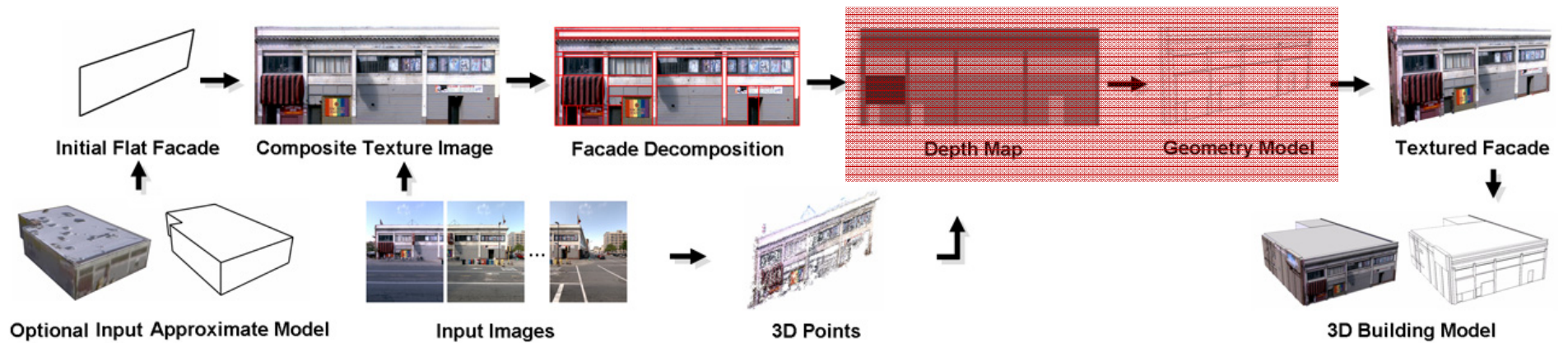
Outline: Façade decomposition



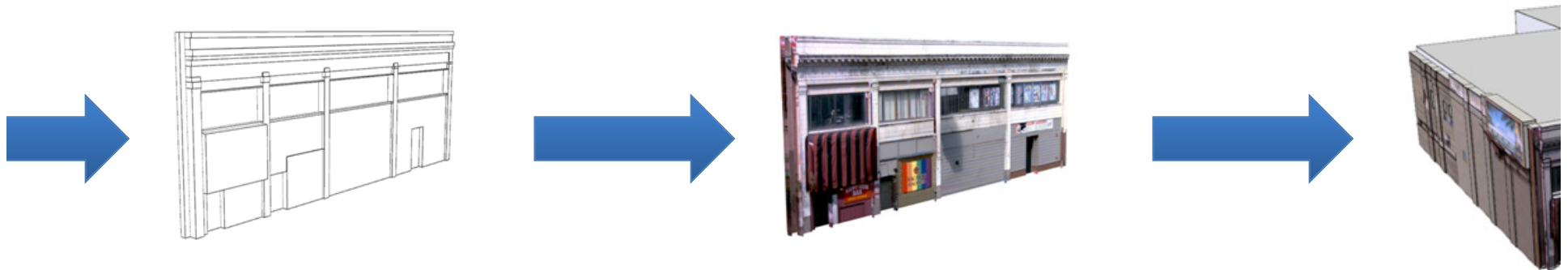
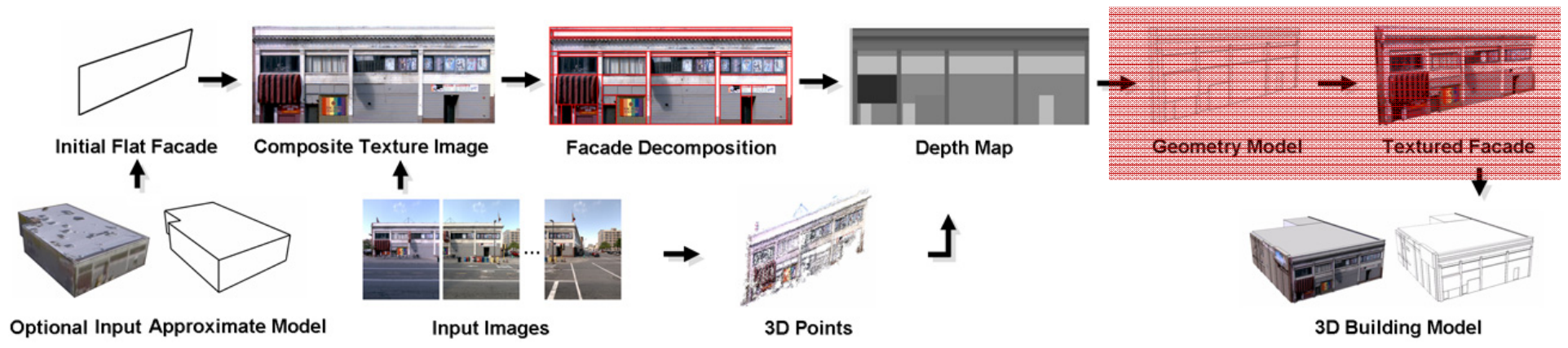
Outline: Façade augmentation



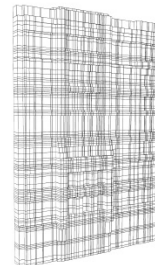
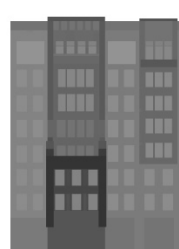
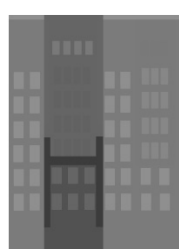
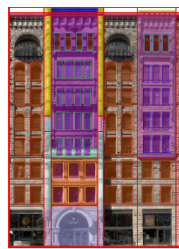
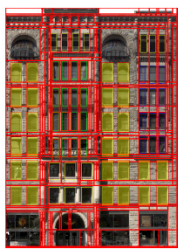
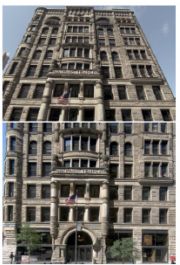
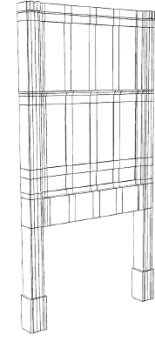
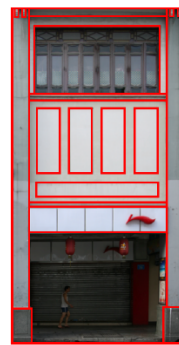
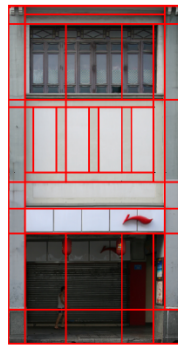
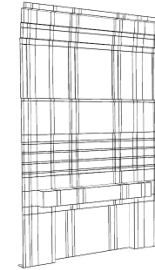
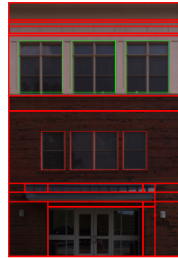
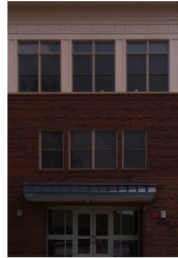
Outline: Façade completion



Outline: Façade completion



Façade Examples



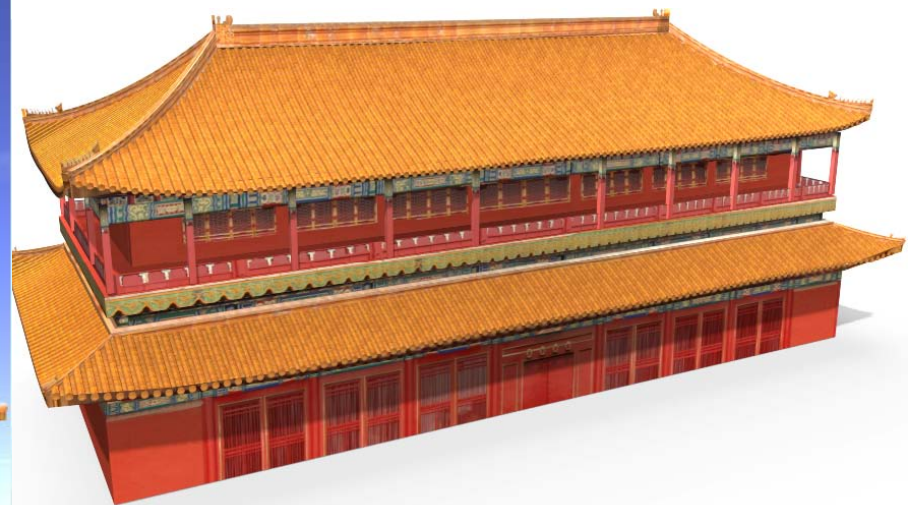
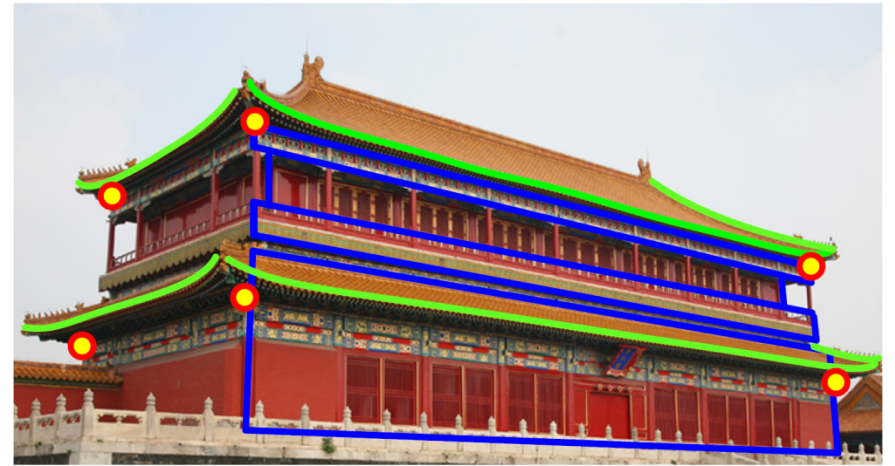
Dishifu Road @ Canton



Reconstruction from a single image using symmetry

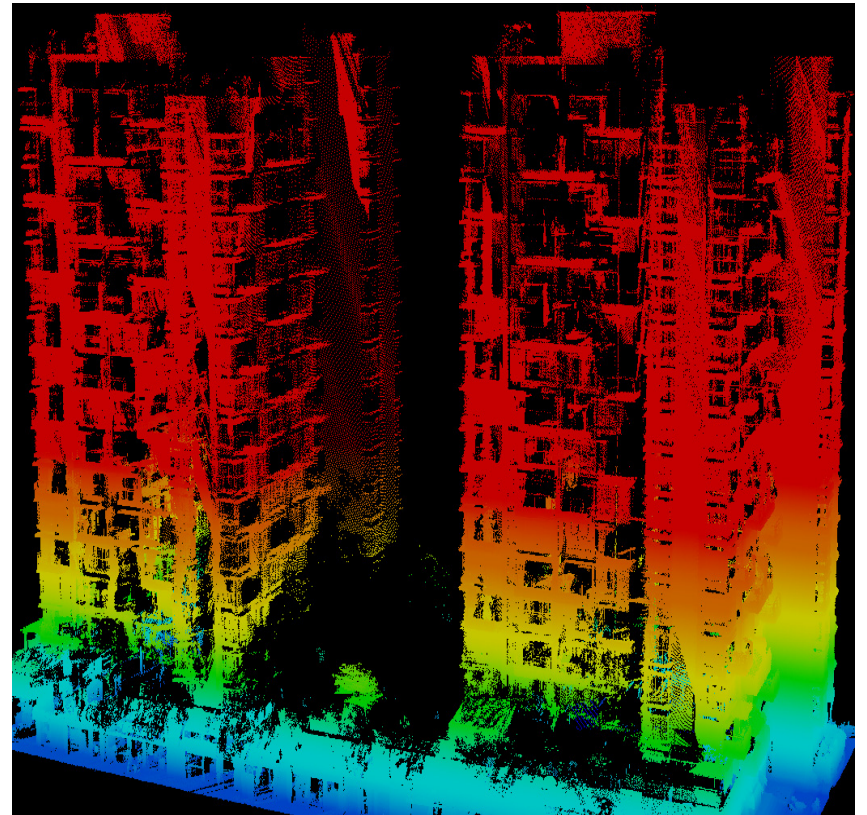
- **Symmetric Architecture Modeling with a single image**

Jiang, Tan, Cheong
SIGGRAPH ASIA 2009



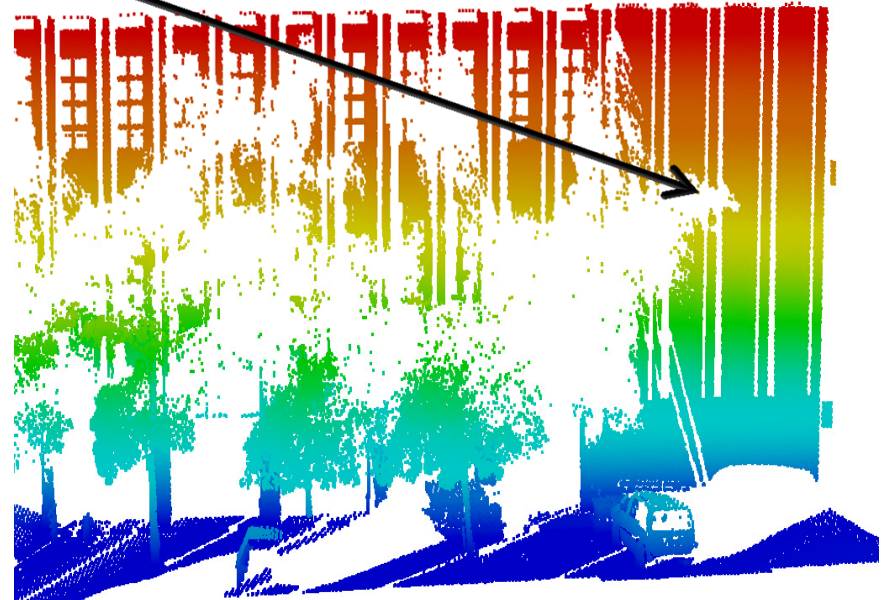
Reconstruction from Lidar

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



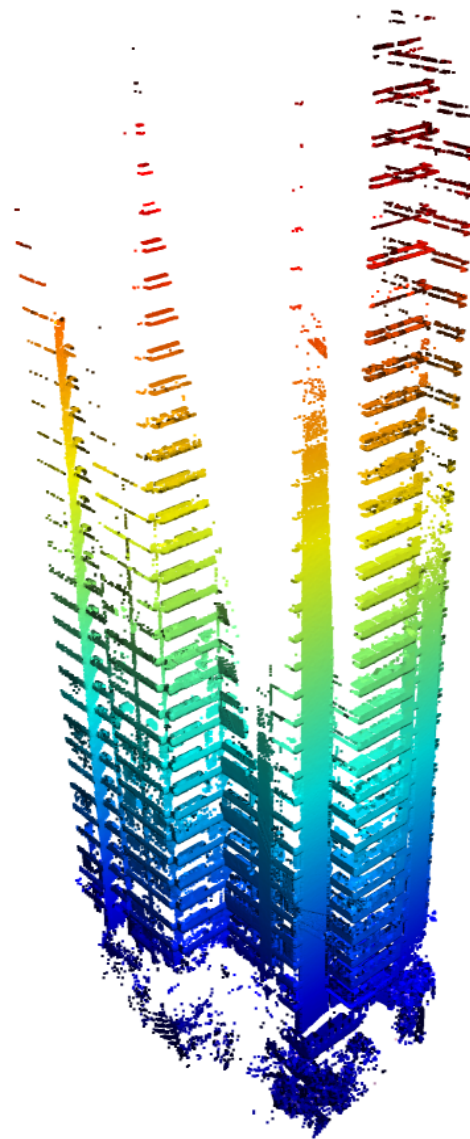
Imperfect Scans - Occlusions

- Point cloud contains holes due to various occlusions (“shadows”)



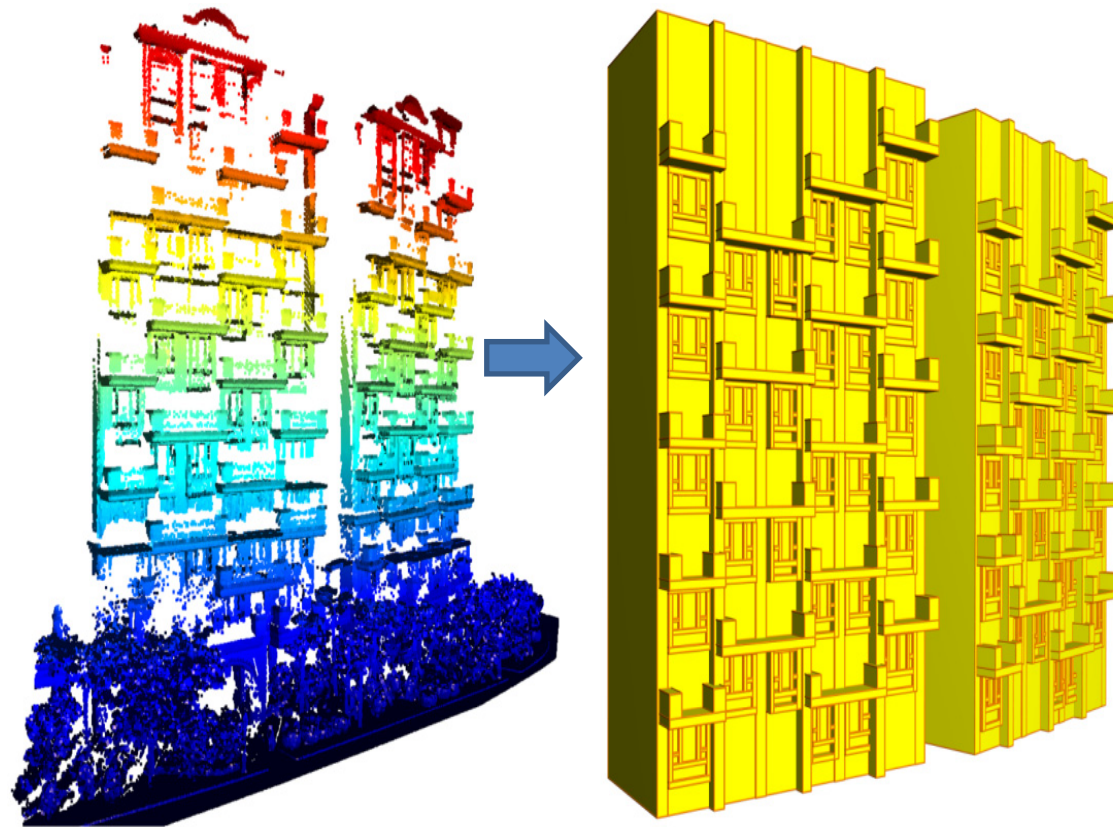
Imperfect Scans – Angle & Range

- Oblique scanning angle
- Laser energy attenuation on range



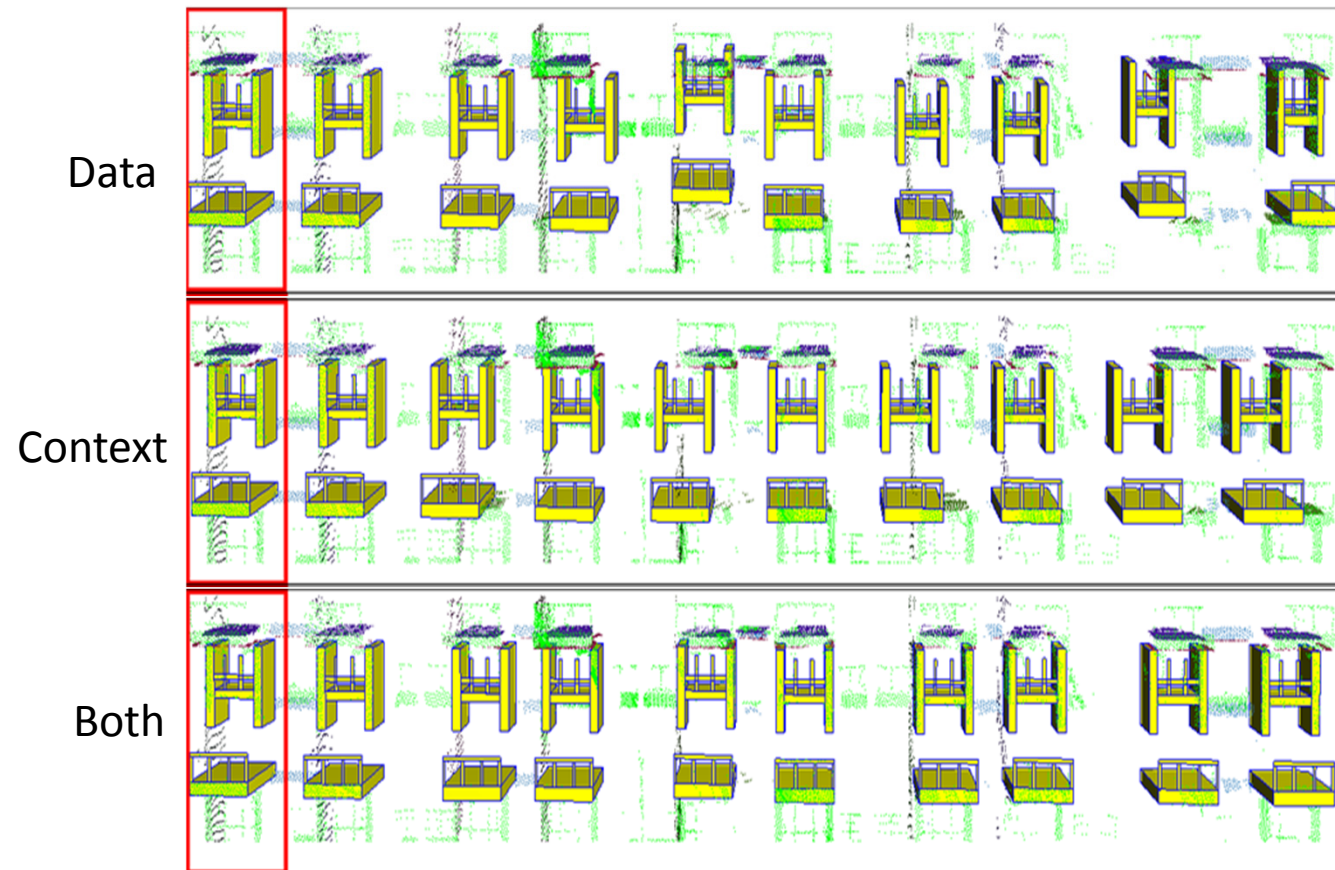
SmartBoxes

- Box-up and Smart!



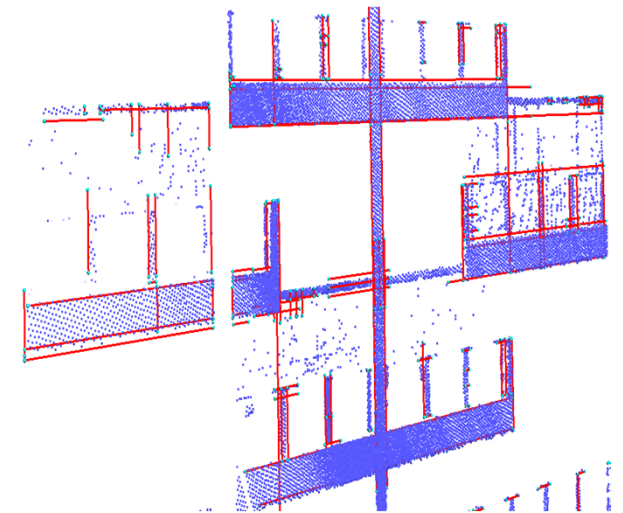
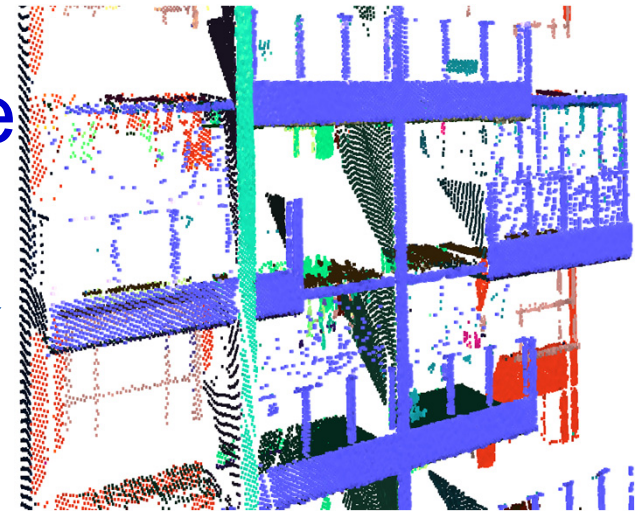
SmartBoxes

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



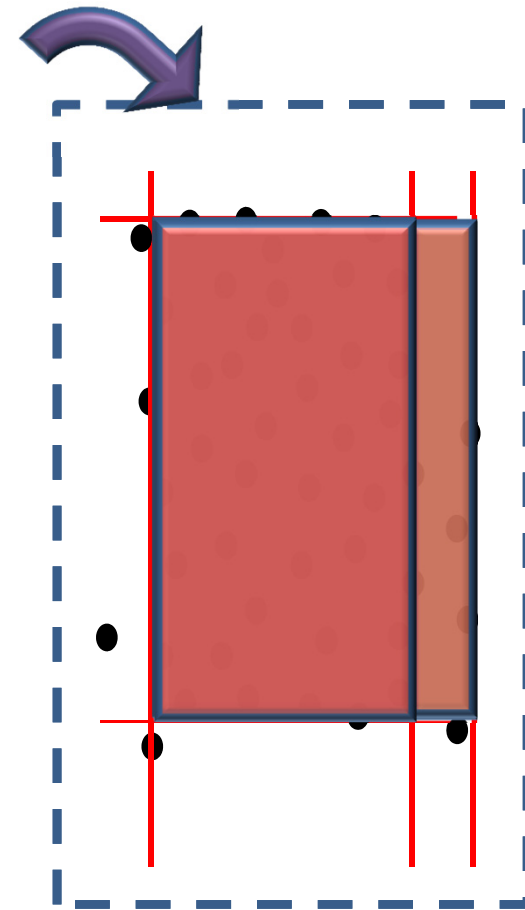
Preprocessing

- Automatic detection of **plane** and **edges** assuming dominant orthogonal axes
 - RANSAC planes
 - Line sweep edges



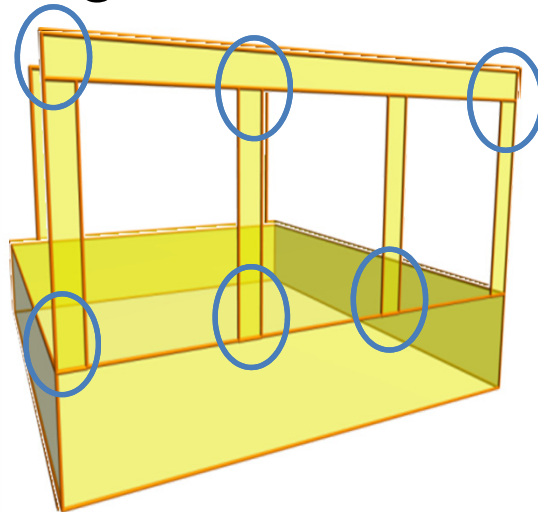
Snapping a Box

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



Grouping

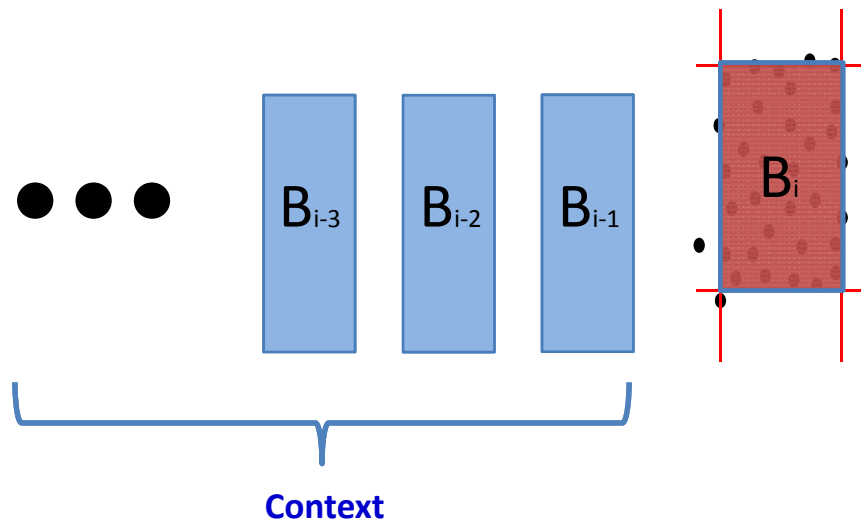
- Simple SmartBox → Compound SmartBox
- Align to remove gaps and intersections
 - cluster and align close to co-linear edges



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

- The context of B_i

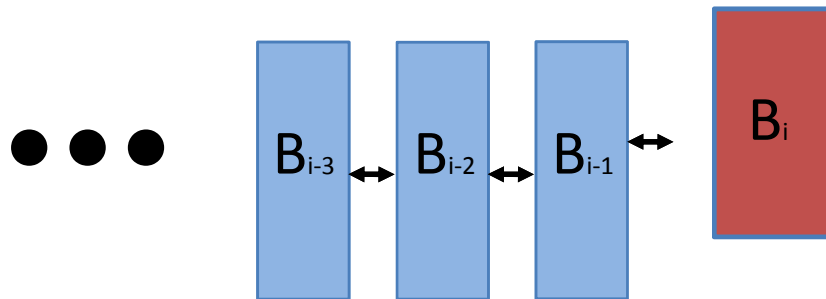
$$C(B_{i-1}, B_i) = \underbrace{I(B_{i-1}, B_i)}_{\text{Interval}} + \underbrace{A(B_{i-1}, B_i)}_{\text{Alignment}} + \underbrace{S(B_{i-1}, B_i)}_{\text{Scale}}$$



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

- The context of B_i
 - Interval term

$$I(B_{i-1}, B_i) = \left| \left\| \text{center}(B) - \text{center}(B_{i-1}) \right\| - \left\| \text{center}(B_{i-2}) - \text{center}(B_{i-2}) \right\| \right|$$



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

- The context of B_i
 - Alignment term

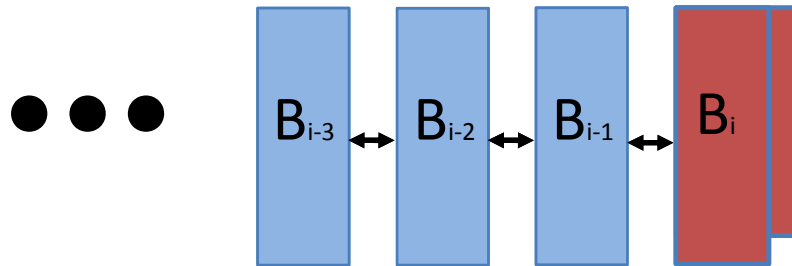
$$A(B_{i-1}, B_i) = \sum_{e' \in B_{i-1} \text{ \& } e \in B_i \text{ correspond}} \|l_{ext}(e') - l_{ext}(e)\|_2$$

Diagram illustrating the alignment term $A(B_{i-1}, B_i)$. The diagram shows a sequence of blocks B_{i-3} , B_{i-2} , B_{i-1} , and B_i . The blocks B_{i-3} , B_{i-2} , and B_{i-1} are blue, while B_i is red. A red dashed line extends from the top of B_{i-1} to the top of B_i . A green dashed line extends from the top of B_i to the right. Two blue arrows point from the terms $l_{ext}(e')$ and $l_{ext}(e)$ in the equation to the red and green dashed lines respectively. Ellipses to the left of B_{i-3} indicate a sequence of blocks.

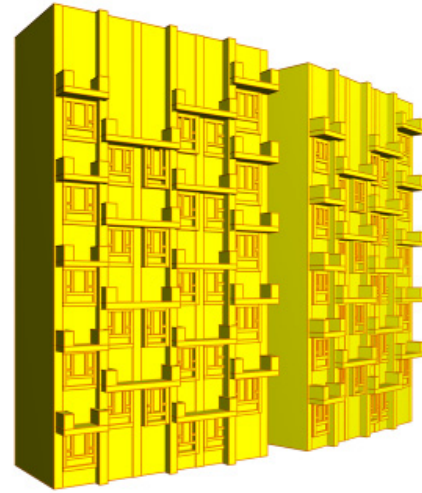
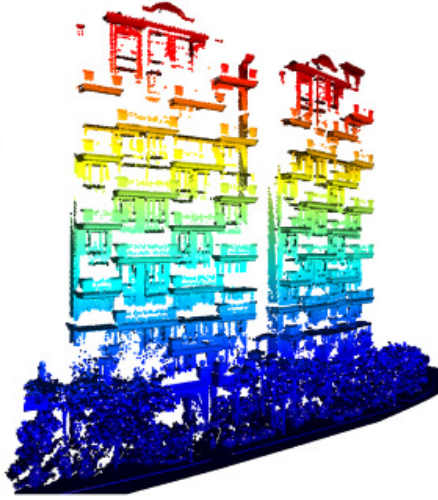
Drag-and-drop context $C(B_{i-1}, B_i)$

- The context of B_i
 - Scale term

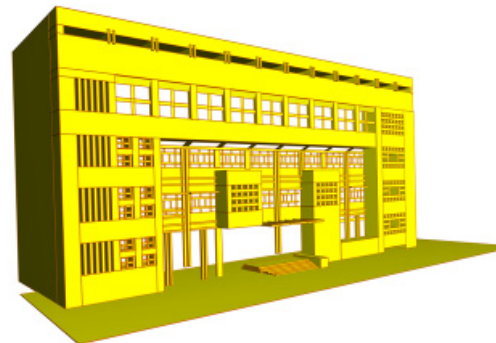
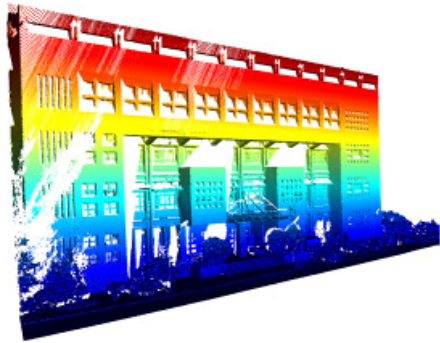
$$S(B_{i-1}, B_i) = \max(\text{diag}(B_{i-1}) / \text{diag}(B_i), \text{diag}(B_i) / \text{diag}(B_{i-1}))$$



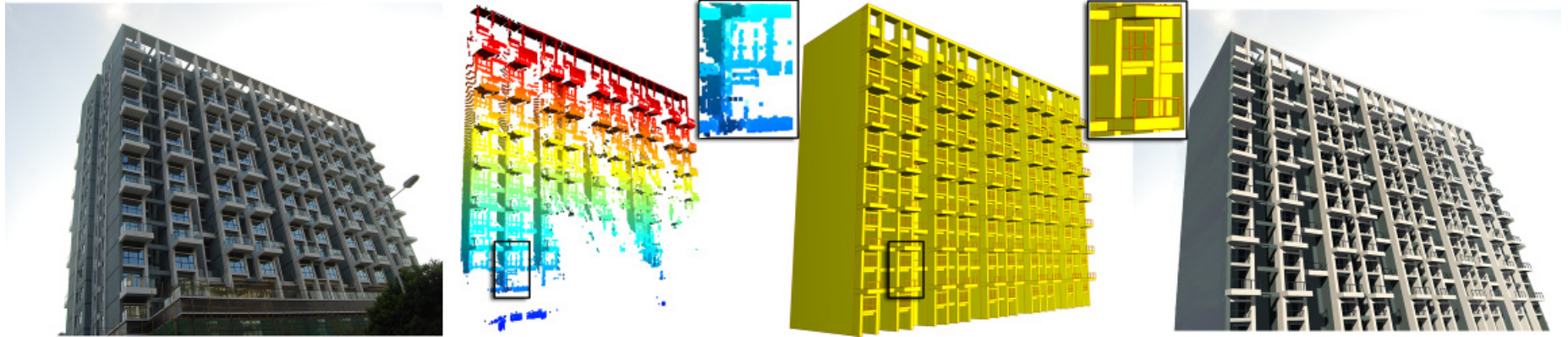
Results: textured buildings



Results: textured buildings



Results: textured buildings



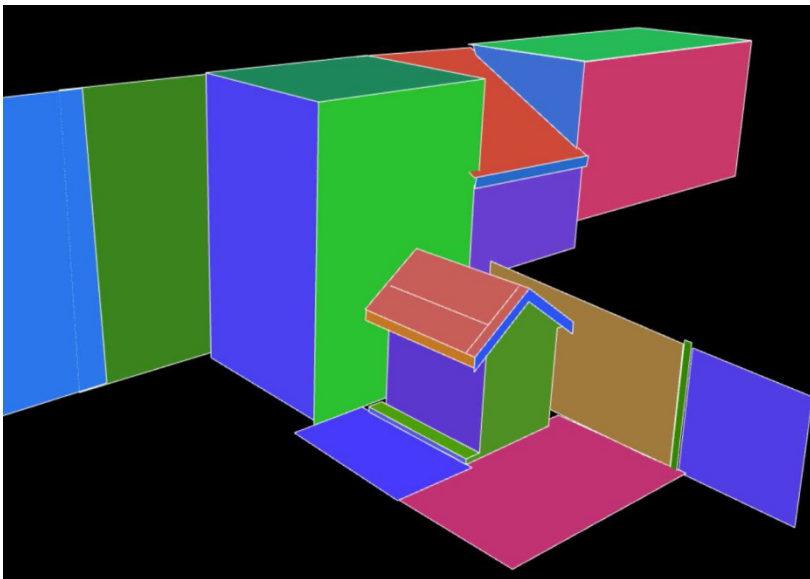
Reconstruction from Multiple Images

- **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