Sharp Reconstruction of Building Geometry
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Problem Statement

- Given scans of urban environments
  - Laser Range Data
Problem Statement

- Want to create 3D computer models
  - Centimeter-level accuracy
  - High Resolution Texture
Overview

- Existing Approaches
- Input Scans
- Geometry Reconstruction
- Results
Existing Geometry
Reconstruction

- Geometry reconstruction is not a new problem

Stationary scanning can yield excellent results

fountain-R25, Strecha et al., CVPR 2008

Alexa et al. 2003

Digital Michelangelo Project

Turk and Levoy, 1994
Existing Urban Modeling

- Aerial Range Data
Scan Input

- **Street-Level LiDAR**
  - High density point-cloud
  - High resolution photography
  - Limited viewing of environment

Photos courtesy of gizmodo.com
Street-Level Scanning

- Occlusion concerns
Street-Level Scanning

- Occlusion concerns
Street-Level Scanning

- Window concerns
Street-Level Scanning

- Desired Model

No holes

Sharp Corners
Input Point-Cloud
Input Building Façade
(Top)
Point-cloud Resampling

Areas of **undersampling**

- **Noisy oversampling**

Uniformly resample
Point-cloud Resampling

- Original Points
Point-cloud Resampling

- Grid Resampled using Moving Least-Squares (MLS)
Geometry Reconstruction
Geometry Reconstruction

- What about the holes?
Geometry Reconstruction

- Sharp Hole Filling

Geometry with hole  Possible Solution #1  Possible Solution #2
Geometry Reconstruction

- Fitting Deepest Planes

MLS Samples

Hole Points
Geometry Reconstruction

- Model Results - Ledge
Geometry Reconstruction

- Model Results - Windows
Geometry Reconstruction

- Model Results - Windows
Geometry Reconstruction

- Example Pointcloud
Geometry Reconstruction

- Just MLS Resampling
Geometry Reconstruction

- Fit Axis-aligned planes

[Diagram showing vertical and horizontal planes]
Results
Results (Textured)
Results (Textured)
Results (Textured)
Results (Textured)
Results (Textured)
Extra: Moving Least-Squares
Moving Least-Squares

- Treat each point as a delta-function
Moving Least-Squares

- Convolve with Gaussian smoothing filter
Moving Least-Squares

- Analyze signal along chosen direction
Moving Least-Squares

- Choose sample at local maxima
Moving Least-Squares

- Repeat
Extra: Existing Techniques
Existing Urban Modeling

- Previous Ground-Based Range Data
  - Reconstruction specific to scan
Extra: Extrapolating Façades
Extrapolating Façades

- Laser scanner has finite height/range
Extrapolating Façades

- Can extrapolate by assuming rectangular face
Extrapolating Façades

- Extrude shape from below
Extra: Geometry Reconstruction Details
Geometry Reconstruction

- Fitting Deepest Planes

Side View

Front View

MLS Samples

Hole Points
Geometry Reconstruction

- Fitting Deepest Planes

Side View

Front View