Watertight As-Built Architectural Floor Plans Generated from Laser Range Data

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Home Owners?

Bettmann/CORBIS, Wall Street Journal

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Home Owners?

Made any renovations?

Bettmann/CORBIS, Wall Street Journal

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Home Owners?

Made any renovations? Have latest blueprints?

Bettmann/CORBIS, Wall Street Journal

Goal



Millions of 3D points

2D Floor plan

Point Clouds of Building Interiors

Methods for Collection:







Wheeled



Ambulatory

Point Clouds of Building Interiors

Point-cloud from Mobile Cart

Floor Plans

Actual Building Floor Plan



Floor Plans

- Desired Output
 - Watertight
 - Simplicial Complex



How has this been tried before?

Top-down 2D histogram of input points

Hough Transform to find lines in histogram

B. Okorn, X. Xiong, B. Akinci, and D. Huber. Towards automated modeling of floor plans. 3DPVT 2009.













- Floating walls
- Output lines are unordered



- Floating walls
- Output lines are unordered
- Requires complete scan of building

• Too many points!

• 3D point-cloud — 2D wall samples



Point-cloud from static scans

Too many points!

3D point-cloud ---- 2D wall samples

Connect wall samples



• Too many points!

3D point-cloud ---- 2D wall samples



• Too many points!

3D point-cloud ---- 2D wall samples

Define interior area



Too many points!

3D point-cloud ---- 2D wall samples

- Define interior area
- Export boundary



- Too many points!
 - 3D point-cloud ---- 2D wall samples
- Define interior area
- Export boundary
- Fit circles, lines



Algorithm

Given full point-cloud



Algorithm: Find Each Story

Separate stories in point-cloud







Algorithm

Reduce 3D point-cloud to 2D wall samples









Filter grid cells



• Filter grid cells, keep if:



- Has 50 points or more
- Uniform coverage from floor to ceiling
- Points distributed along a line

Get wall sample from cell



Get wall sample from cell



Neighbor points of a grid cell

Get wall sample from cell



Neighbor points of a grid cell

Median position is 2D wall sample

18 Million points

Point-cloud from static scanners

3,568 wall samples

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Algorithm

Delineate interior area with *Eigencrust*

 R. Kolluri, J. R. Shewchuk, and J. F. O'Brien. Spectral surface reconstruction from noisy point clouds. Symposium on Geometry Processing 2004, pages 11–21, July 2004.



Guarantees *watertightness*



Algorithm: Eigencrust

Delaunay Triangulation



Algorithm: Eigencrust

Weighted graph connects triangles





Algorithm: Eigencrust

Weighted graph connects triangles

• Negative edges: $w_{u,v} = -e^{4+4\cos\phi+2\sin\theta_1+2\sin\theta_2}$





Output of *Eigencrust*

Exported Boundaries



2D Wall Samples Labeled Triangles Exported Boundary

Fit Lines and Circles to Boundary





Three stories extracted (1st floor)







Ambulatory Mobile System 17.3 million points



Output floor plan

207



29

Wall samples

 Three stories extracted (2nd floor)



Ambulatory Mobile System 17.3 million points

Output floor plan

10 m

0

5 m





Wall samples

-3:00

Three stories extracted (3rd floor)



Ambulatory Mobile System 17.3 million points

Output floor plan

10 m

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5 m

Actual building plan







Results





Summary



3D point cloud



Labeled triangles

University of California Berkeley



Watertight boundary

Thank You