

Scan2Floorplan: Floor Layer-based Kernels and Pillars of Points (FLKPP)

Yijie Wu, Maosu Li and Fan Xue

Faculty of Architecture, The University of Hong Kong

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Dr. Fan Xue

Who are we?

Yijie Wu

Yr-1 PhD student, Dept. Real Estate & Construction Research interest: <u>Building reconstruction</u> from point clouds

Maosu Li

Yr-3 PhD candidate, Dept. Urban Planning & Design Research interest: <u>Semantics in CIM</u>, 3D view assessment

Fan Xue

Asst Prof, Dept. Real Estate & Construction; Dept. Urban Planning & Design (Part-time) Research interest: <u>Digital twin buildings/city</u>, optimization, LiDAR processing, <u>explainable AI</u>



Maosu Li

<u>Yijie Wu</u>

Fan Xue

Outline

- I. Background
- II. Our method
- **III.** Results
- **IV.** Discussion & future work

Scan2Floorplan in AECO

3D scan



- $\,\%\,$ Consistent with the real layouts
- $\,\%\,$ Rich in details and appearance
- $\,\%\,$ Much faster than traditional survey



Floorplan



 \times Most commonly used in AECO

- ***** A great amount of achieved floorplans
- % Low acquisition cost
 - **#** Boost data-driven methods

Challenges in Scan2Floorplan



3D scan

- \times Geometry fitting
- % Semantics understanding
- \times Data deficiencies

Floorplan



- ※ Drawn for human interpretation rather than machine processing
 - # Flexible layer naming, annotations & topology
- \times Inconsistent with the real layouts

Step by step vs. End to end

Step by step

Preprocessing (e.g., downsampling, axis aligning, outlier/clutter/horizontal structure removal) semantic segmentation, RANSAC fitting, topology repairing, ...



Excellent and guaranteed results presented in the 2D leaderboard of last year

End to end

FloorPP-Net in 2021 Scan2BIM 2D Challenge Project the point clouds to 2D and learn to output a floorplan (edges)



Without careful network design and parameters tuning, output noisy results (3rd place in 2D Challenge last year)



Han et al., 2021



FLKPP: A framework with both step-by-step & end-toend



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Preprocessing

(Voxels occupied

by scan data)

(Indoor

space

voxels)

E C C C

WECC

E

W

₩AIMs:

- **#** Room clustering
- # Room-base noise removal
- ※ Space voxels labeling
- ※ Region growing to segment rooms
- ※ Clutter removal (using head levels in rooms)







(Zoom-in)



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2D edge detection

FloorPP-Net



2D edge detection



End-to-End Wireframe Parsing

2D edge detection

2D edge completion, guided by **explainable** floorplan objects



Semantic segmentation of point cloud by KPConv



walls, doors, and stairs

Results

02_TallOffice_01_F7



20 cm pre: 16% | rec: 29% | iou: 85%

08_ShortOffice_01_F1



20 cm pre: 14% | rec: 21% | iou: 90%

Results

11_MedOffice_05_F1



20 cm Pre.: 12% | Rec.: 20% | IoU: 50%

25_Parking_01_F2



20 cm Pre.: 4% | Rec.: 0.12 | IoU: 0.76

Ablation study

→	Clutter removal	Sem. Seg.	LCN N	FloorPP-Net	IoU @ 20cm	Pre. @ 20cm	Rec. @ 20cm	Betti error
	\checkmark	\checkmark	\checkmark	\checkmark	37.4%	13.2%	25.3%	1.12
	\checkmark	\checkmark			36.4%	25.1%	6.6%	1.29
	\checkmark		\checkmark	√	39.2%	10.4%	16.6%	1.24
				~	12.0%	6.5%	38.6%	1.20

Discussion & future work

*☆*Limitations

- **#** A lot of clutters; missing exterior points
- # The inconsistencies between floorplans and point clouds in the 2D edge learning
- # Incomplete topology (connection & closure)

\times Future work

- **#** To design **rules** for clutter removal
- **#** To build a classifier handle the **inconsistencies**
- # To **repair** the topology (Learning? Graph? Domain knowledge?)



Suggestions

- # Inconsistent metrics? (IoU@20cm = 42%, Pre.@20cm = 4.5%, Rec.@20cm = 3.2%)
- **#** Evaluation code (Bounding the extent when match the regions | Without classification evaluation)

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Thank you for listening!



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