SimpliCity: Reconstructing Buildings with Simple Regularized 3D Models

Jean-Philippe Bauchet [1,*], Raphael Sulzer [1,2,*], Florent Lafarge [2], Yuliya Tarabalka [1]
[1] LuxCarta Technology, [2] Centre Inria d'Université Côte d'Azur
jpbauchet@luxcarta.com; *equal contribution

Problem statement

How to generate lightweight building models from airborne LiDAR point clouds with the following objectives?

Fidelity
Provide accurate geodata

Simplicity
Regular and simple polygons

Efficiency
Ability to process large-scale areas

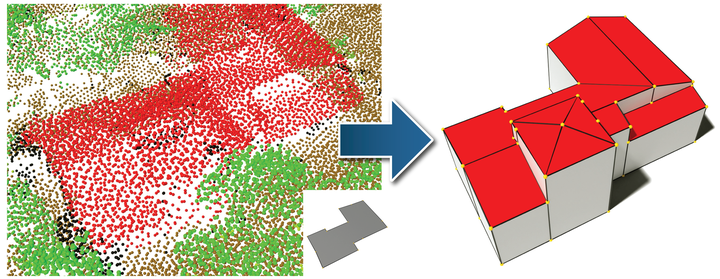
Geometric Guarantees
Watertightness, orientable meshes...

Contributions

Our contributions are twofold:

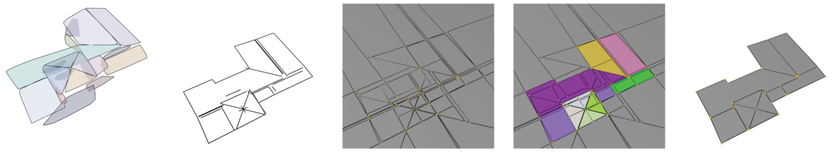
A planimetric arrangement that generates concise, watertight LOD2 building models from LiDAR data based on a 2.5D extrusion

A regularization procedure that simplifies the produced models, while enforcing geometric regularities and preserving geometric guarantees



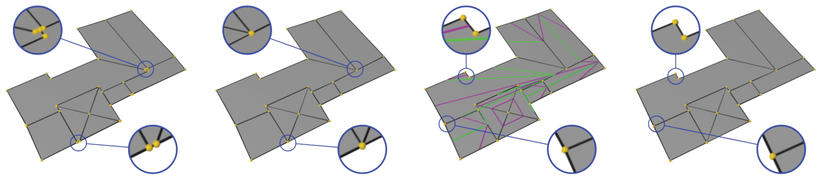
Method

1 Construction of 2D polygonal partition



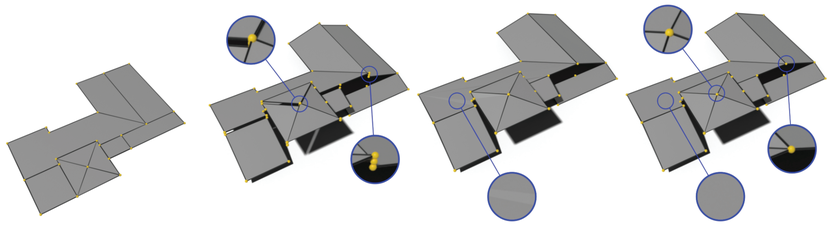
a) Plane detection | b) Line-segment projection | c) Initial partition | d) Labeling | e) 2D polygonal partition

2 Regularization of 2D polygonal partition



a) 2D polygonal partition | b) Vertex simplification | c) Regularity detection | d) Optimization

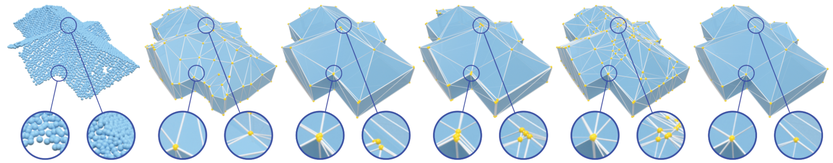
3 Extrusion



a) Regularized partition | b) Cell extrusion | c) Vertex simplification | d) Optimization

Experimental results

Qualitative results on Zurich dataset



Input | 2.5DC [Zhou '10] | KSR [Bauchet '19] | Geoflow [Peters '22] | City3D [Huang '22] | Ours

Quantitative results on Tallinn, Zurich and Helsinki datasets

		Complexity		Accuracy			Performance
		|V|	|F|	$E_{<0.5m}$ [%]	$CD_{Inp \to Rec}$ [cm]	$CD_{Rec \to Ref}$ [cm]	Time [s]
Tallinn	**Reference** [Wang '23]	84.6	47.5	1.28	6.68	-	-
	2.5DC [Zhou '10]	112	187	2.86	11.9	81.9	0.13
	KSR [Bauchet '19]	67.8	71.4	8.35	8.07	15.9	10.4
	Geoflow [Peters '22]	180	172	28.0	7.18	36.4	4.03
	City3D [Huang '22]	116	199	25.0	9.39	7.24	49.1
	Ours	32.2	58.2	4.39	9.34	13.2	4.19
Zurich	**Reference** [stadt-zuerich.ch]	54.6	77.2	4.48	58.3	-	-
	2.5DC [Zhou '10]	140	241	2.57	16.4	50.6	0.052
	KSR [Bauchet '19]	116	139	8.72	22	33.2	6.52
	Geoflow [Peters '22]	227	220	27.0	28.1	50.0	1.59
	City3D [Huang '22]	112	193	28.3	30.6	20.0	42.3
	Ours	58.3	109	7.48	26.6	26.0	3.82
Helsinki	**Reference** [kartta.hel.fi]	203	236	8.97	66.2	-	-
	2.5DC [Zhou '10]	570	1045	2.67	22.6	69.9	1.15
	KSR [Bauchet '19]	619	704	14.5	39.8	39.2	67.9
	Geoflow [Peters '22]	900	883	23.1	34.2	54.7	6.12
	Ours	214	393	9.5	32.3	37.1	6.81

Future work

Accurate footprint extraction from LiDAR data | Block-level regularization of neighboring buildings | Release as a Web service