Learning to Construct 3D Building Wireframes from 3D Line Clouds
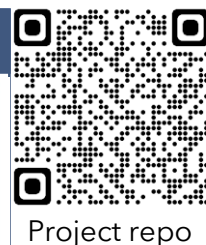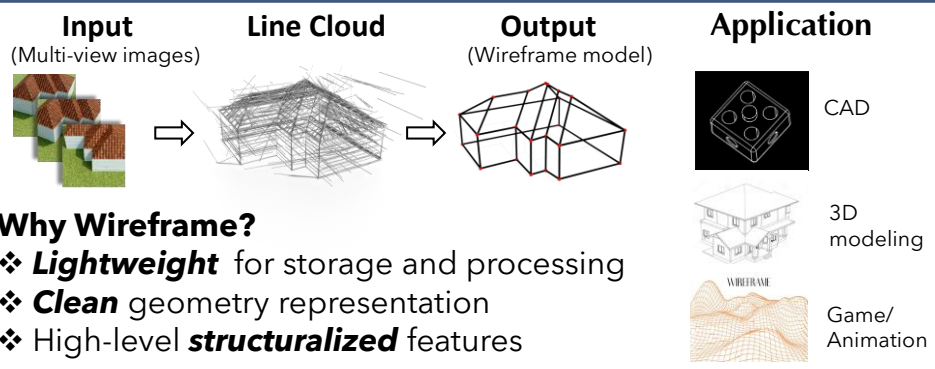
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1. Introduction

Input (Multi-view images) ⇒ **Line Cloud** ⇒ **Output** (Wireframe model)
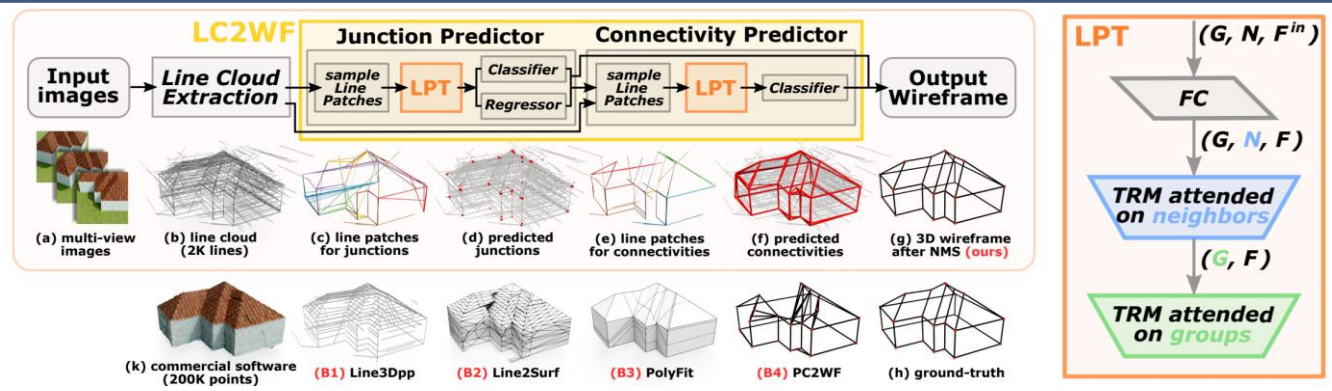
Application: CAD, 3D modeling, Game/Animation

Why Wireframe?
- ❖ *Lightweight* for storage and processing
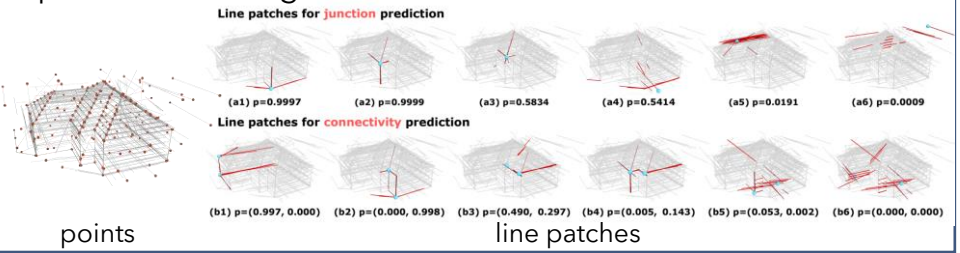- ❖ *Clean* geometry representation
- ❖ High-level *structuralized* features

2. Contributions

- ❖ A novel *learning-based* solution to reconstruct *3D building wireframe* from Multiview images
- ❖ *LC2WF*: a *transformer-based* and *first* network to process line clouds based on *line patches*
- ❖ An adapted synthetic *dataset* with annotated multi-view images and *ground-truth 3D wireframe models*

3. Line Patches

Line patch: a group of line segments that encode local geometry
- ❖ Sample *points* w.r.t *density* and *farthest point sampling*
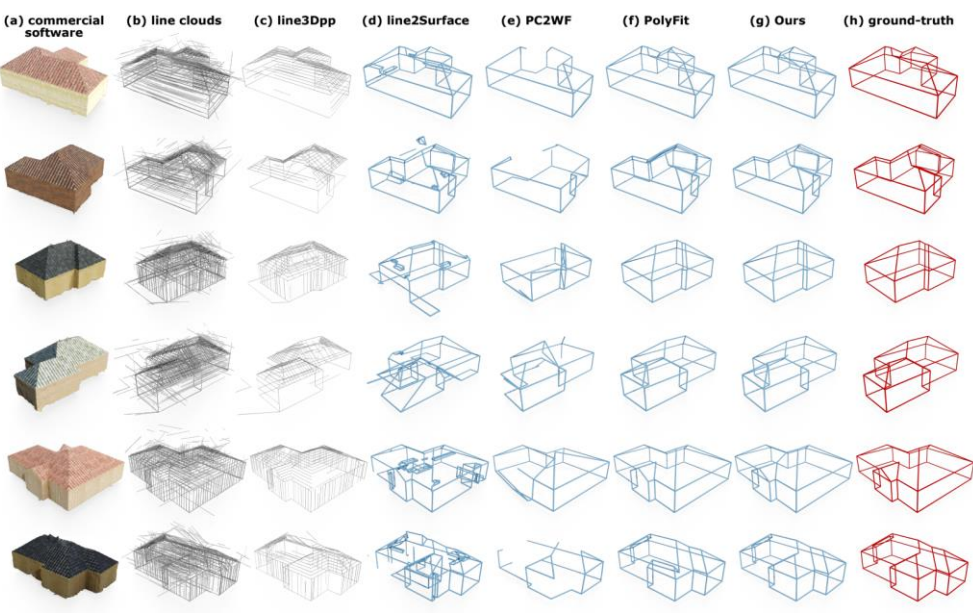- ❖ Sample *line patch* based on distance between the sampled point and line segments

Line patches for junction prediction

(a1) p=0.9997 (a2) p=0.9999 (a3) p=0.5834 (a4) p=0.5414 (a5) p=0.0191 (a6) p=0.0009

Line patches for connectivity prediction

(b1) p=(0.997, 0.000) (b2) p=(0.000, 0.998) (b3) p=(0.490, 0.297) (b4) p=(0.005, 0.143) (b5) p=(0.053, 0.002) (b6) p=(0.000, 0.000)

points   line patches

4. Methodology - LC2WF: line cloud → wireframe

(a) multi-view images (b) line cloud (2K lines) (c) line patches for junctions (d) predicted junctions (e) line patches for connectivities (f) predicted connectivities (g) 3D wireframe after NMS (ours)

(k) commercial software (200K points) (B1) Line3Dpp (B2) Line2Surf (B3) PolyFit (B4) PC2WF (h) ground-truth

Project repo

5. Baselines & Results

Method	$v\text{AP}\eta / v\text{Recall}\eta$ (%)			
	$\eta = 0.15$	$\eta = 0.25$	$\eta = 0.35$	avg.
line2Surf.	26.7/83.9	27.4/85.8	27.6/86.6	27.2/85.4
PolyFit	52.1/70.8	62.0/84.3	64.3/87.4	59.5/80.8
PC2WF	11.9/26.8	43.2/54.3	58.5/65.2	37.9/48.8
Ours	**91.3/92.2**	**93.4/93.9**	**94.4/94.8**	**93.0/93.6**

Precision/Recall of the predicted junctions

Method	$s\text{AP}\eta / s\text{Recall}\eta$ (%)			
	$\eta = 0.15$	$\eta = 0.25$	$\eta = 0.35$	avg.
line2Surf.	24.2/58.8	25.1/61.0	25.8/62.6	25.0/60.8
PolyFit	45.5/53.8	58.7/69.5	65.5/77.5	56.6/66.9
PC2WF	0.84/7.61	7.68/23.3	23.0/40.4	10.5/23.8
Ours	**76.8/84.7**	**80.6/87.1**	**83.9/89.5**	**80.4/87.1**

Precision/Recall of the predicted edge

(a) commercial software (b) line clouds (c) line3Dpp (d) line2Surface (e) PC2WF (f) PolyFit (g) Ours (h) ground-truth

Comparison to baselines on building wireframe reconstruction