NEURAL INFORMATION PROCESSING SYSTEMS

SegGraph: Leveraging Graphs of SAM Segments for Few-Shot 3D Part Segmentation

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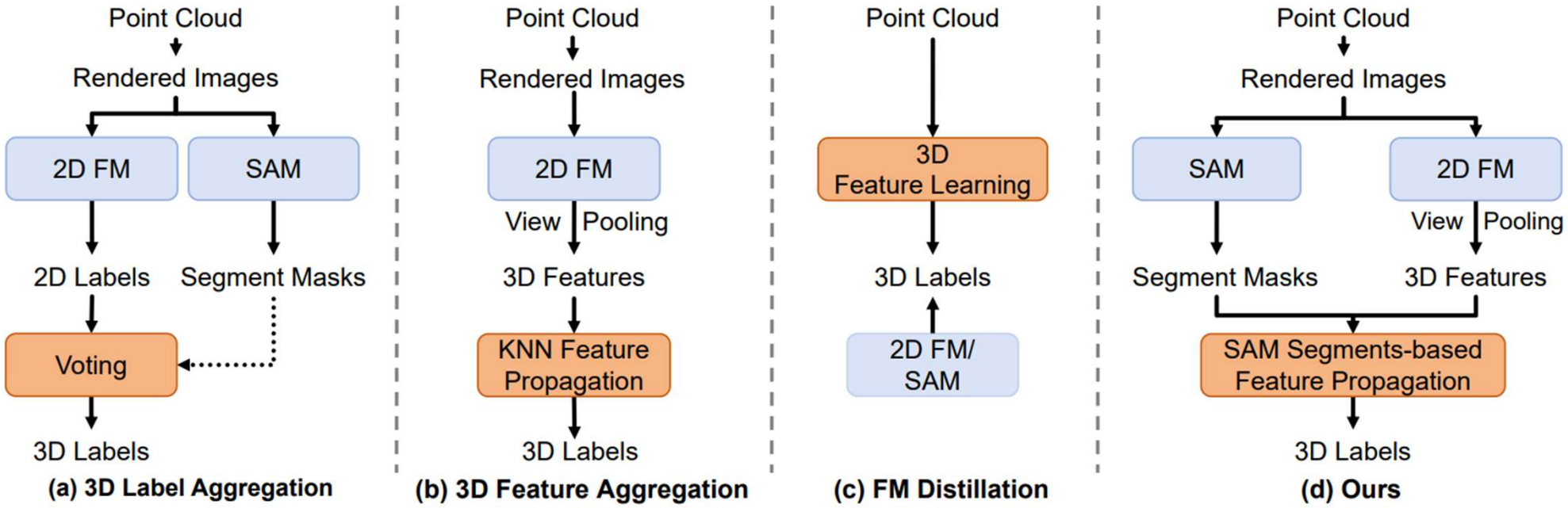
Motivation & Challenges



Key Idea: SegGraph

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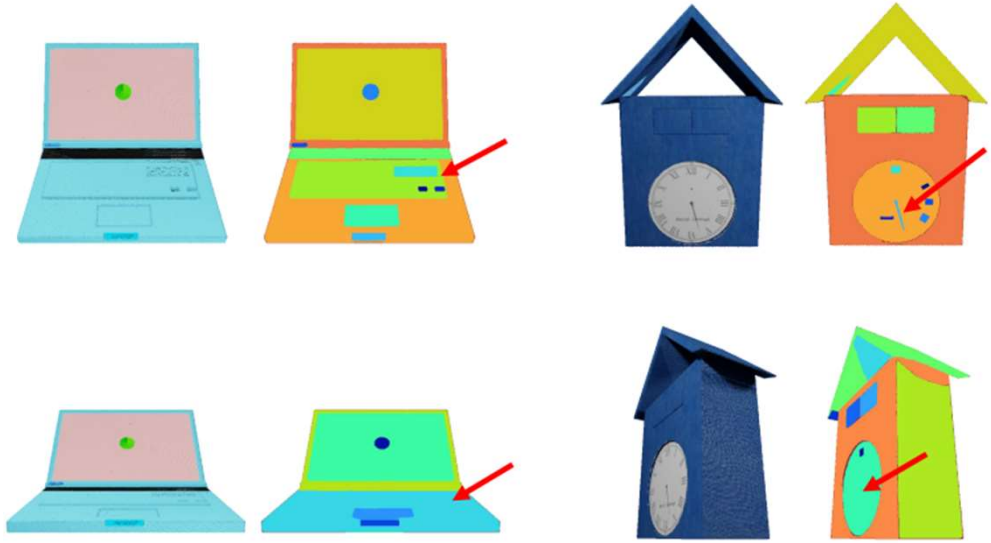
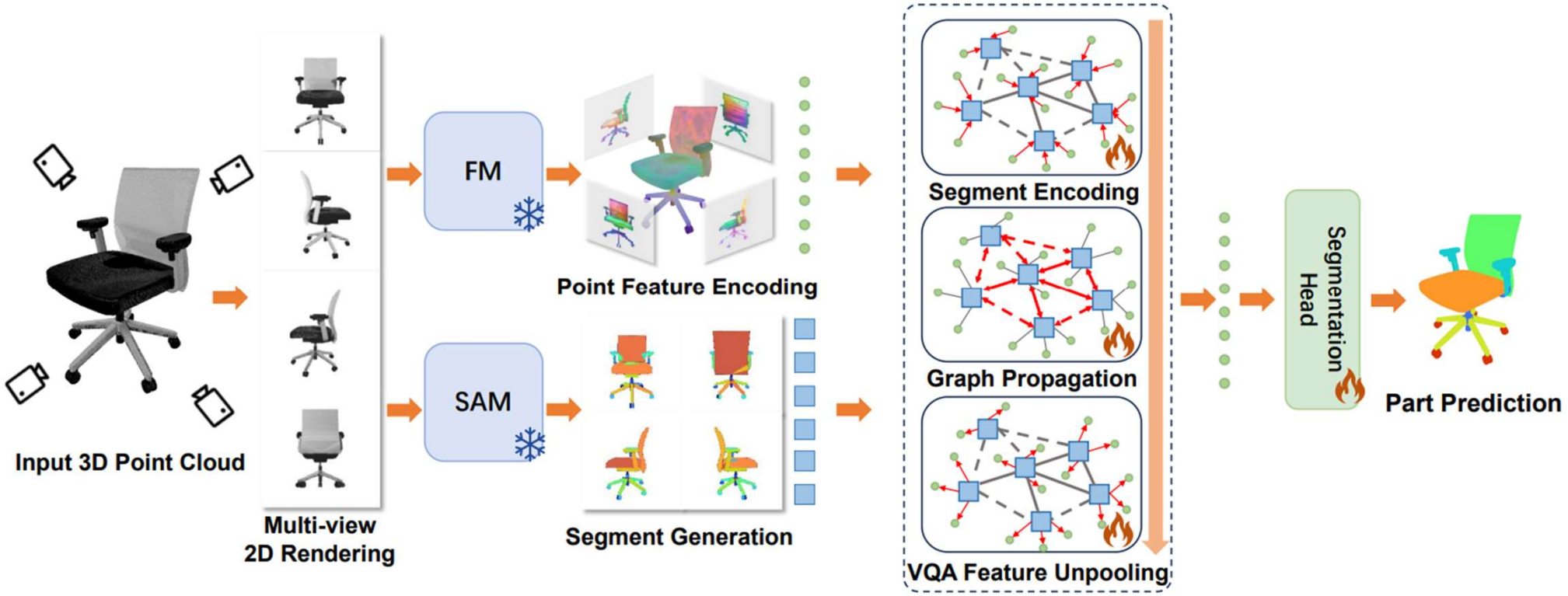
- Use SAM segments as geometric grouping cues
- Construct segment graphs for propagation
- Integrate viewing-quality-aware feature unpooling



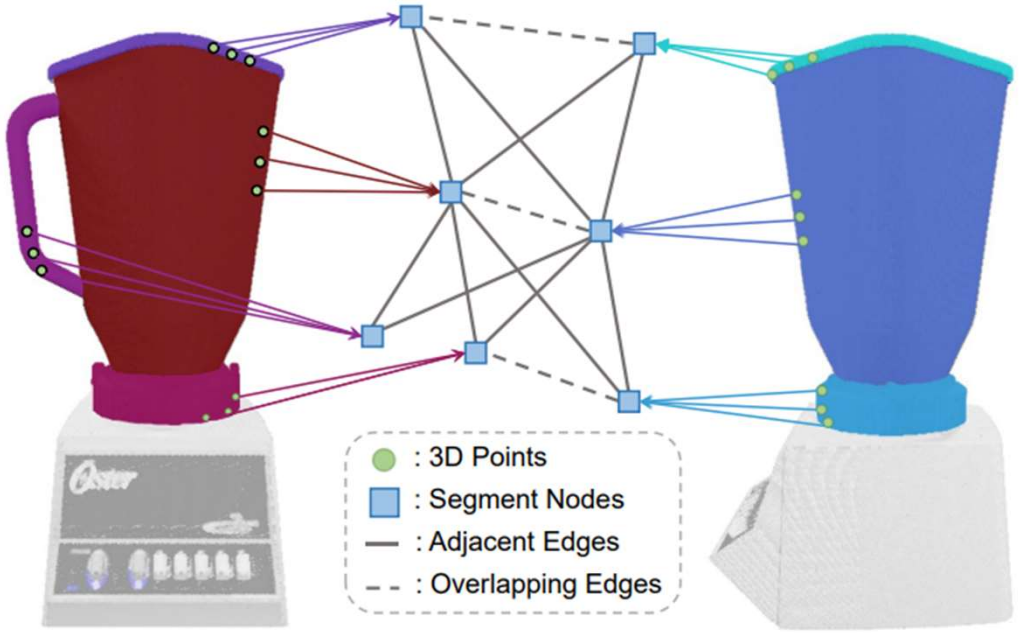
Pipeline


Input 3D Point Cloud
Multi-view
2D Rendering
FM
SAM
Point Feature Encoding
Segment Generation
Segment Encoding
Graph Propagation
VQA Feature Unpooling
Segmentation
Head
Part Prediction

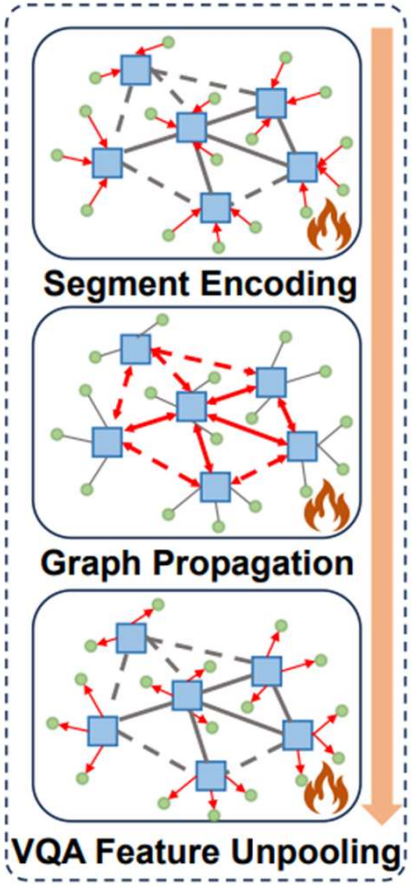
Graph Construction

Two Kinds of Edges:

- Adjacent Edges
- Overlapping Edges



Pipeline



Segment Encoding:

F_S is obtained by attentively weighting each point's DINOv2 feature based on local geometry.

Graph Propagation:

We employ the GATv2 graph neural network for feature propagation.

Viewing Quality-Aware Feature Unpooling:

Each point feature is weighted-unpooled from covering segments using MLP-learned weights based on the angle between the segment's mean normal and the camera ray.

Main Result

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Methods	FM	Overlapping Categories (17)						None-Overlapping Categories (28)						(45)
		Bottle	Chair	Door	Knife	Lamp	Overall	Camera	Dispe.	Kettle	Oven	Suitca.	Overall	Overall
PointNet++ [26]	-	48.8	84.7	45.7	35.4	68.0	55.3	6.5	12.1	20.9	34.4	40.7	25.0	36.5
SoftGroup [50]	-	41.4	88.3	53.1	31.3	82.2	50.4	23.6	18.9	57.4	13.7	18.3	31.3	38.5
PointNext [37]	-	68.4	91.8	43.8	58.7	64.9	59.1	33.2	26.0	45.1	37.8	13.6	45.5	50.6
PartSLIP [6]	GLIP	83.4	85.3	40.8	65.2	66.1	56.3	58.3	73.8	77.0	73.5	70.4	61.3	59.4
PartSLIP++ [11]	GLIP & SAM	85.5	85.3	45.1	64.3	68.0	59.7	63.2	72.0	85.6	70.3	70.0	63.5	62.1
PartSTAD [12]	GLIP & SAM	83.6	85.3	61.4	63.8	68.4	61.4	64.4	73.7	84.2	71.9	68.3	67.1	65.0
3-By-2 [7]*	SD & SAM	80.9	84.4	54.4	75.1	59.5	60.4	62.6	78.2	81.5	60.0	65.2	66.5	64.2
PartDistill [13]*	GLIP & SAM	84.6	88.4	55.5	71.4	69.2	64.6	60.1	74.7	78.6	72.8	73.4	66.7	65.9
PartField [15]	SAM	75.9	87.6	65.4	72.9	73.8	65.7	52.0	73.9	82.4	50.2	72.0	66.7	66.3
SegGraph (ours)	GLIP & SAM	**87.5** (± 1.73)	**88.5** (± 0.69)	**69.5** (± 0.45)	**79.3** (± 1.70)	**84.2** (± 2.19)	**69.1** (± 2.04)	**66.7** (± 0.88)	**74.8** (± 2.39)	**88.2** (± 1.20)	**70.2** (± 3.40)	**72.8** (± 1.54)	**71.5** (± 2.13)	**70.4** (± 2.08)
	DINOv2 & SAM	**90.0** (± 0.66)	**89.5** (± 0.44)	**73.6** (± 0.15)	**77.3** (± 0.06)	**78.5** (± 0.73)	**70.1** (± 0.80)	**70.8** (± 1.01)	**77.6** (± 0.36)	**87.8** (± 0.47)	**75.7** (± 1.28)	**77.3** (± 1.28)	**74.4** (± 1.23)	**72.8** (± 1.09)

Ablation Study

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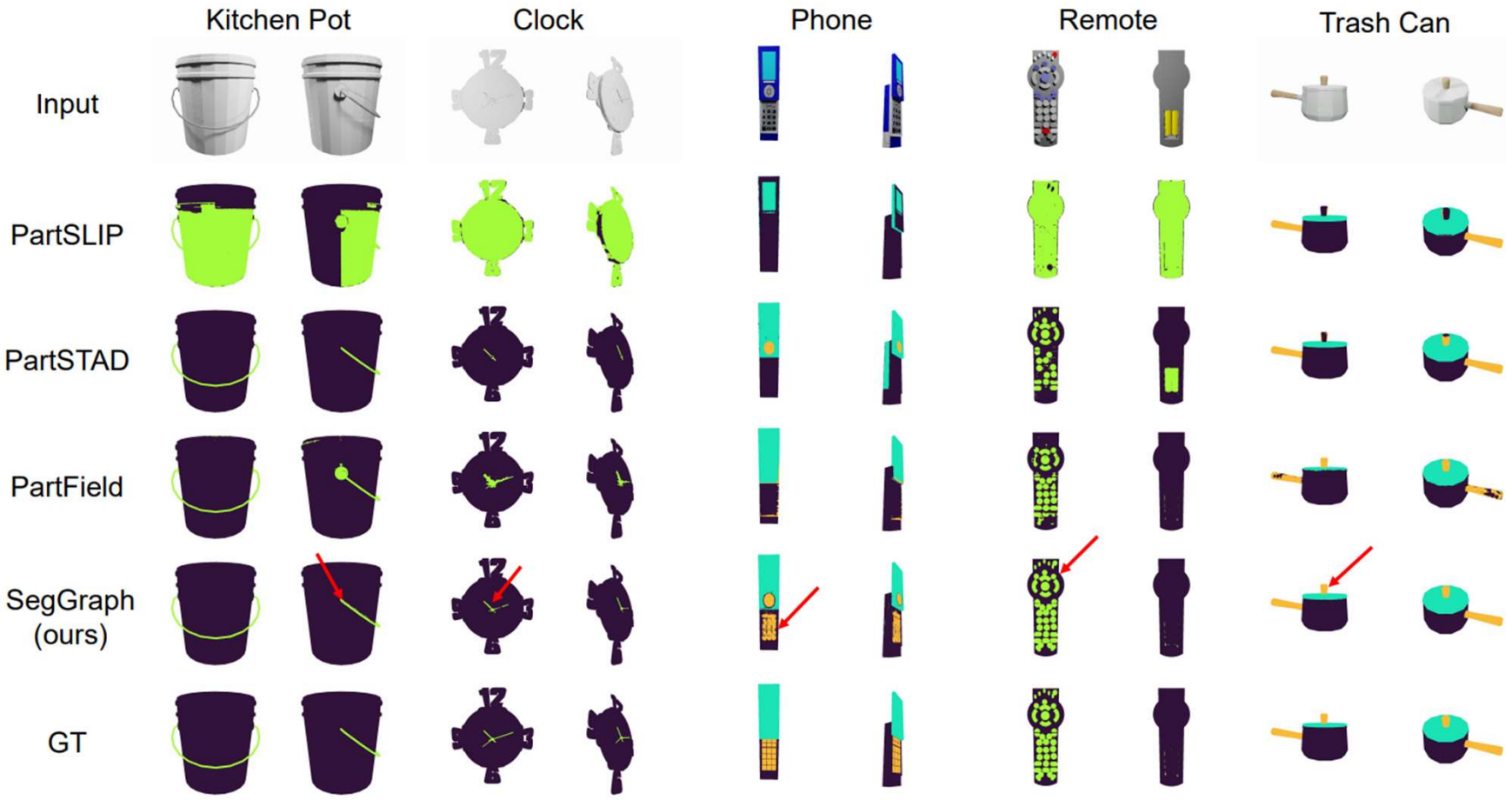
	SAM	AVE→SE	AVE→Eq.(2)	$\mathcal{E}_o$	$\mathcal{E}_a$	Bottle	Door	Suitca.	Overall(45)
(1)						83.8	62.2	70.3	65.2
(2)	✓					89.0	72.7	70.5	70.5
(3)	✓	✓				88.7	72.8	67.7	70.7
(4)	✓		✓			88.7	72.5	65.5	70.5
(5)	✓	✓	✓			87.9	72.3	66.9	71.0
(6)	✓			✓	✓	87.8	70.5	73.0	71.4
(7)	✓	✓	✓	✓		89.0	73.3	74.4	72.2
(8)	✓	✓	✓		✓	89.7	72.6	74.0	72.3
(9)	✓	✓	✓	✓	✓	90.0	73.6	77.3	72.8

		Bottle	Door	Suitca.	Overall (45)
CLIP [42]	MLP	63.2	35.0	44.0	39.3
	SegGraph	71.2	36.5	52.1	49.5
Diffusion [9]	MLP	78.8	54.0	59.1	56.8
	SegGraph	85.0	59.0	69.4	64.3
GLIP [8]	MLP	82.1	57.7	62.1	61.1
	SegGraph	87.4	69.5	72.8	70.4
PartField [15]	MLP	75.9	65.4	72.0	66.3
	SegGraph	76.6	70.9	75.9	70.3
DINOv2 [43]	MLP	82.0	62.8	68.5	65.2
	SegGraph	90.0	73.6	77.3	72.8

Visualization



Thanks