SIGGRAPH ASIA 2023 SYDNEY

Online Scene CAD Recomposition via Autonomous Scanning

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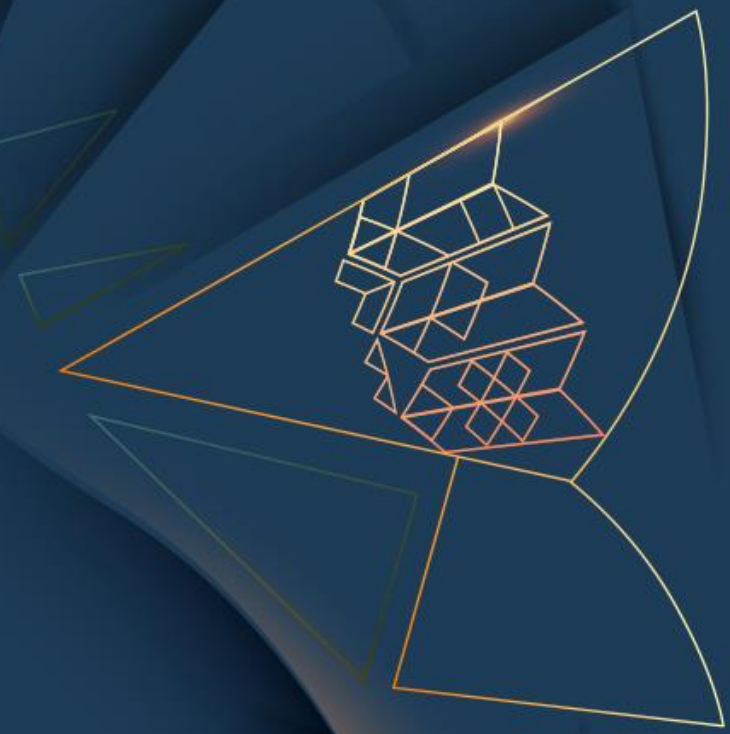
Ligang Liu, University of Science and Technology of China



Connecting STORIES
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CONFERENCE 12 - 15 December 2023
EXHIBITION 13 - 15 December 2023
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ASIA.SIGGRAPH.ORG/2023

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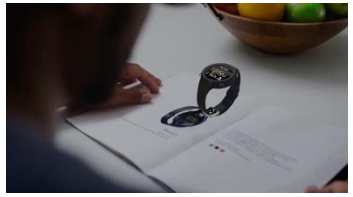
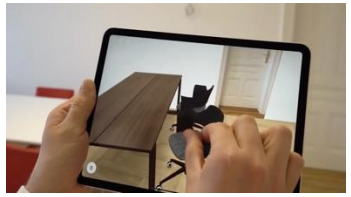
Background



Visualization

Augmented Reality



Interaction

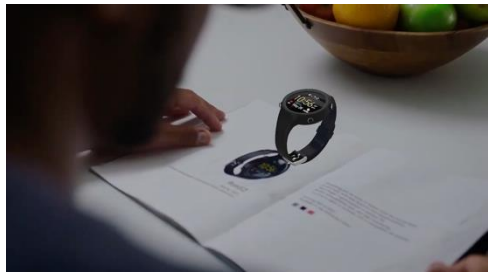
Virtual Reality

Interior Design

Mixed Reality

Background

Interaction



Visualization

Augmented Reality

Require clean and concise models for
editing,
interaction,
rendering,
……

Interior Design

Mixed Reality

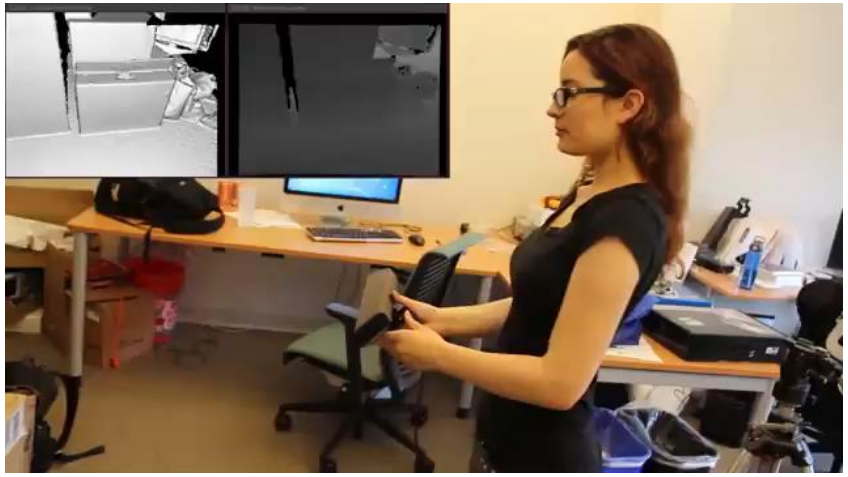
Virtual Reality

Surface Reconstruction

Surface Reconstruction

- Online
- Accurate surface

- Noisy data
- Geometric errors



[KinectFusion, Izadi et al. 2011]

[NBO, Liu et al. 2018]

CAD Recomposition

Surface Reconstruction

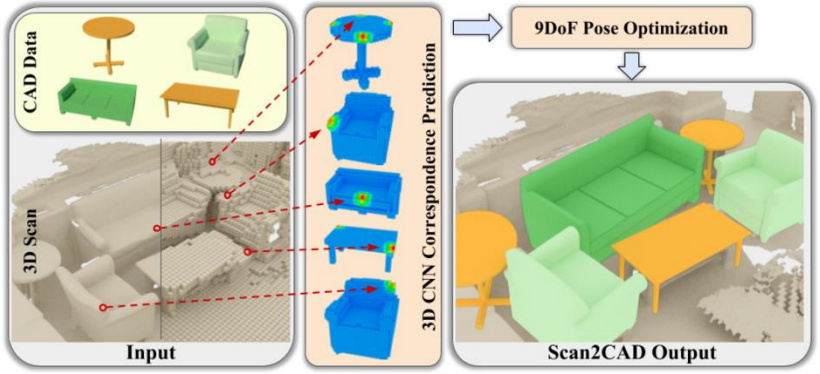
- Online
- Accurate surface

- Noisy data
- Geometric errors

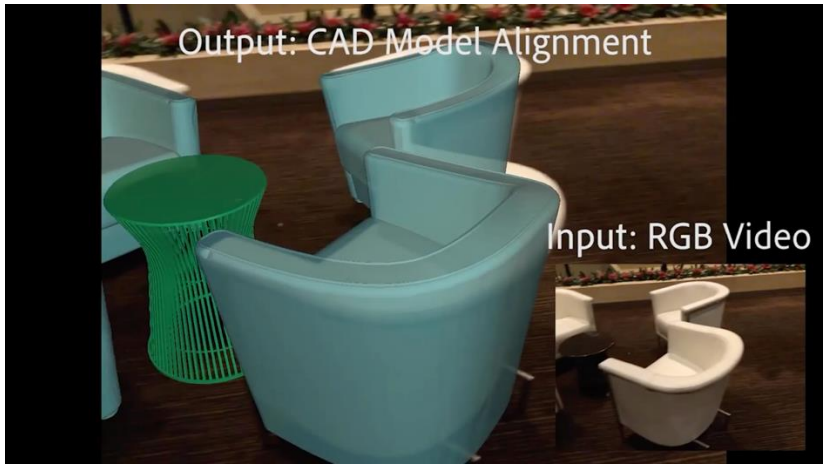
CAD Recomposition

- Clean and concise geometry
- Object-level segmentation

- Offline
- Retrieval errors



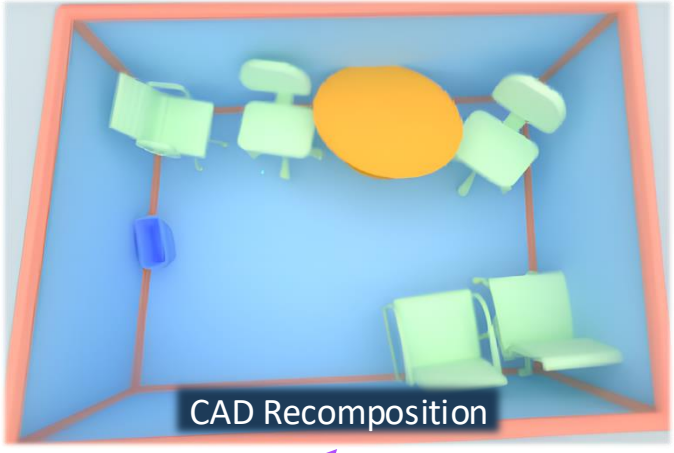
[Scan2CAD, Avetisyan et al. 2018a]



[Vid2CAD, Maninis et al. 2022]

Key Observation

Do we really need the surface reconstruction?



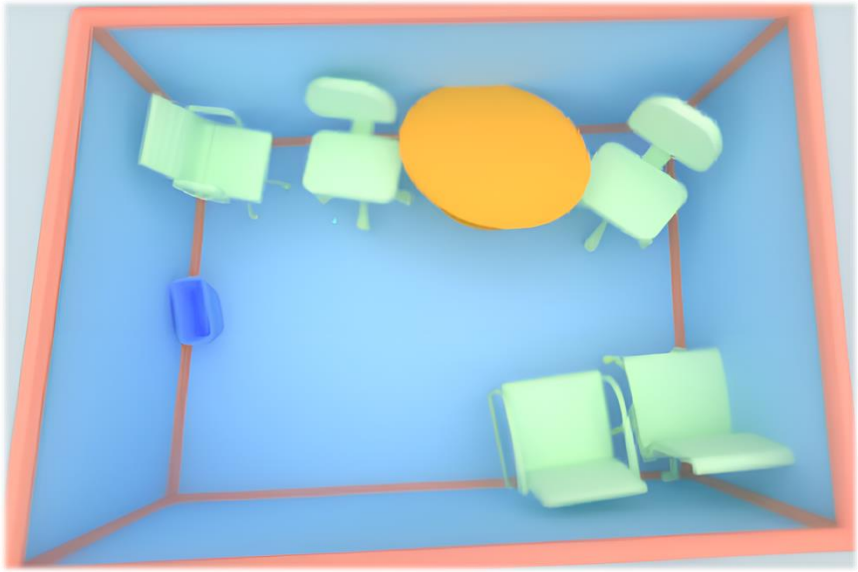
Surface Reconstruction
Only get reconstructed surface

Offline CAD Recomposition
Based on reconstructed surface

Key Observation

Surface reconstruction is not necessary
for online CAD recomposition

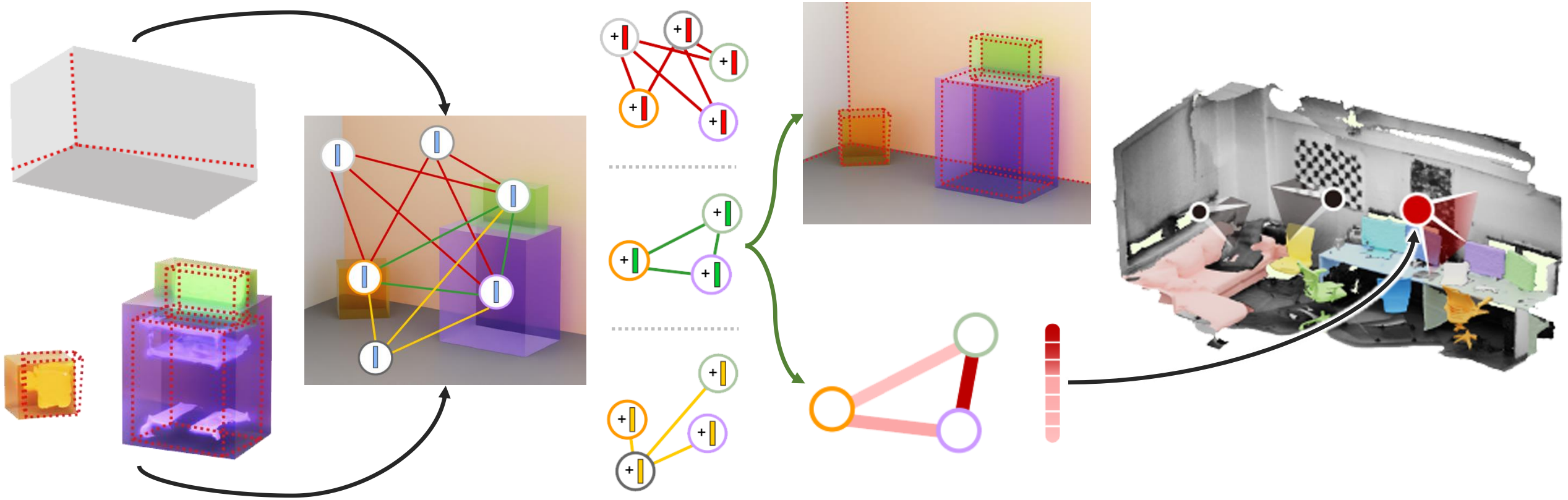
Real Scene



CAD Recomposition

Key Idea

Relation as constraint and guidance

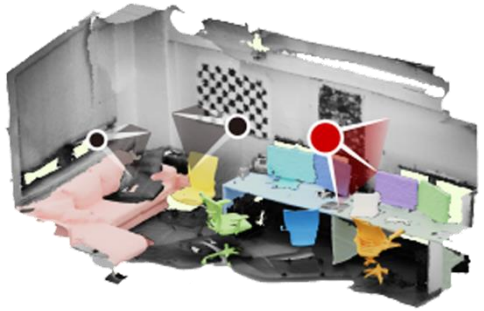


Overview

Info update

Relation-guided
scene CAD recomposition

Scanned RGB-D observation



Relation-aware
NBV generation

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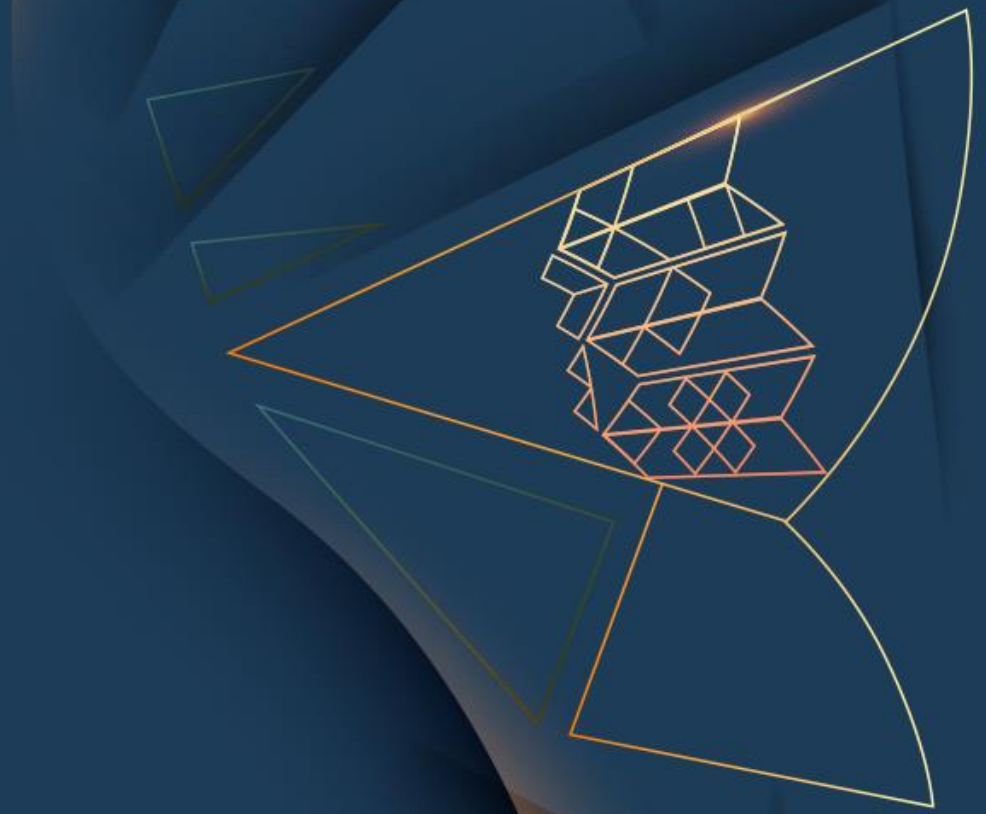

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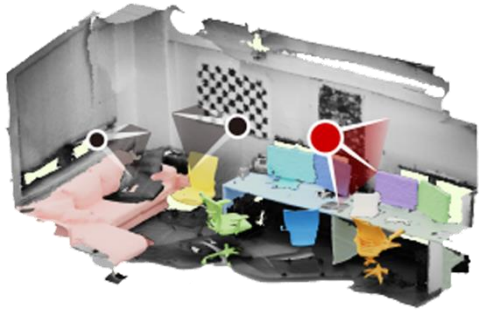

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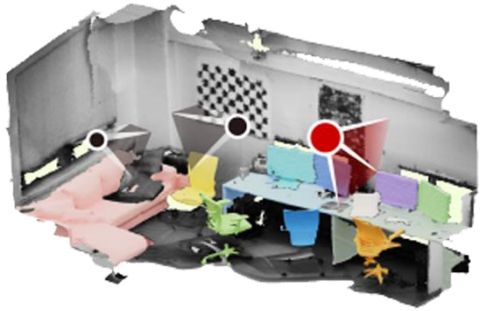


Relation-aware
NBV generation

Scanned RGB-D observation

Info update

Object point clouds with background

Scanned RGB-D observation

Fusion

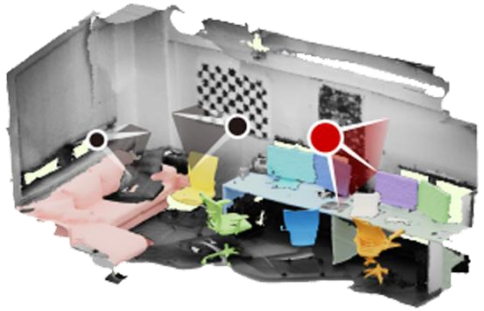
Map Builder

2D occupancy grid

Overview

Info update

Relation-guided
scene CAD recomposition



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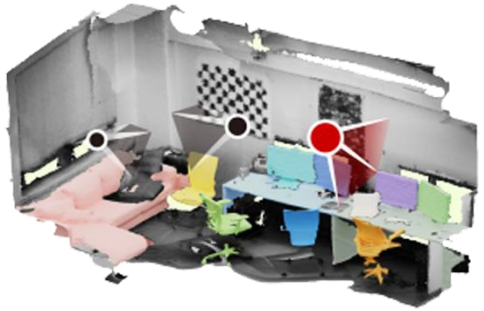

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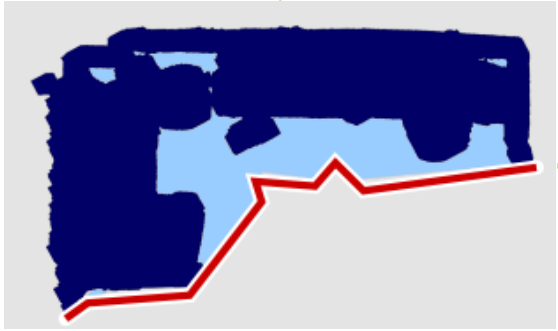
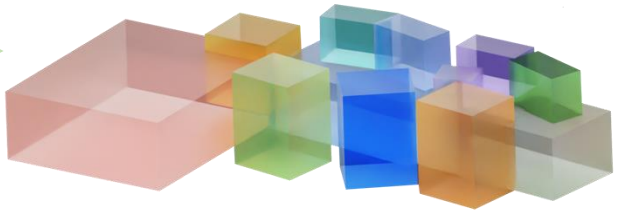


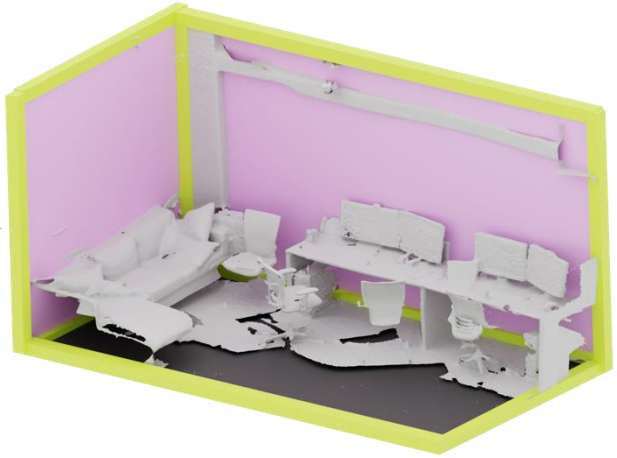
2D occupancy grid

Object Pose Estimation

Oriented bounding boxes



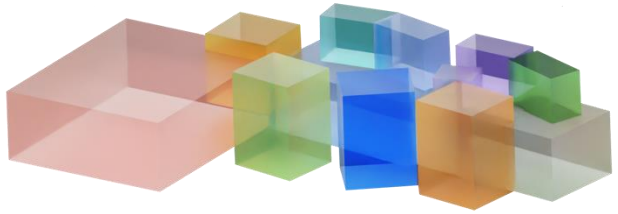
Layout Construction



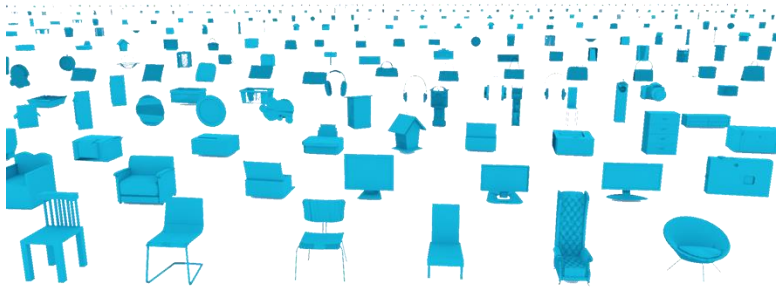
Walls & Floor

CAD Recomposition

Oriented bounding boxes



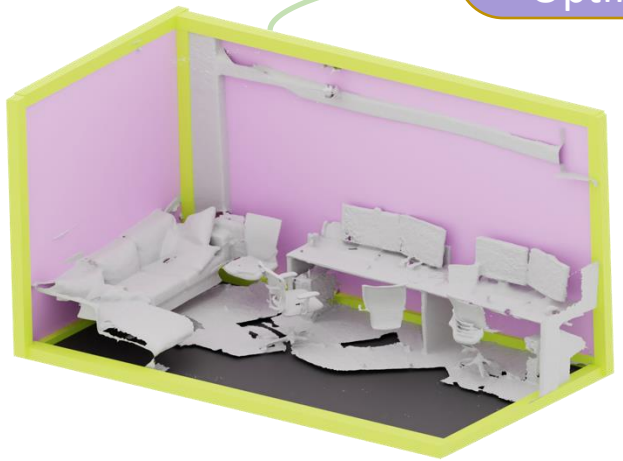
CAD dataset



CAD recomposition

Relation-guided Optimization

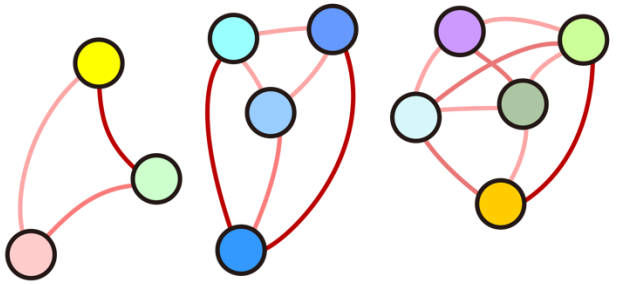
Geometry-aligned CAD Retrieval



Walls & Floor

Refined OBB & Object point clouds

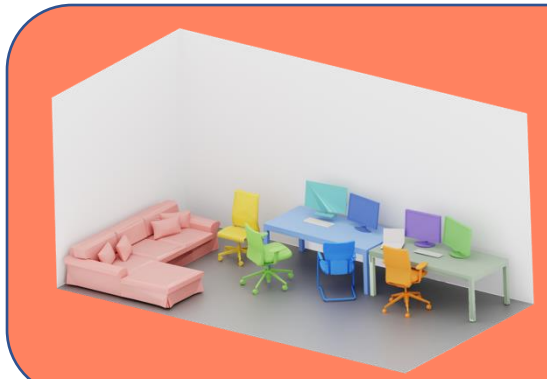
+



Predicted relation

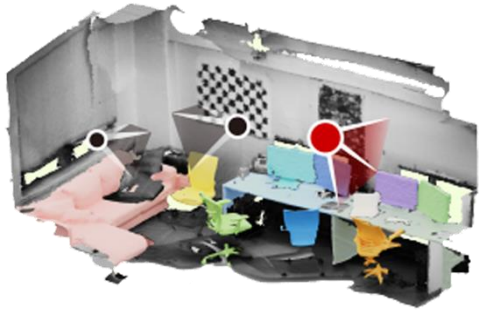
Overview

Info update



Relation-guided
scene CAD recomposition

Scanned RGB-D observation



Relation-aware
NBV generation

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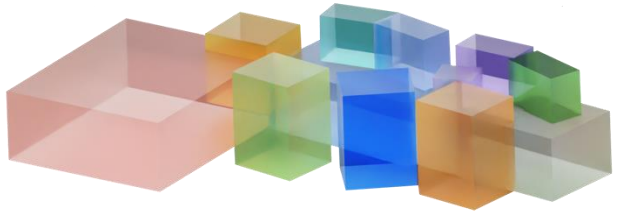
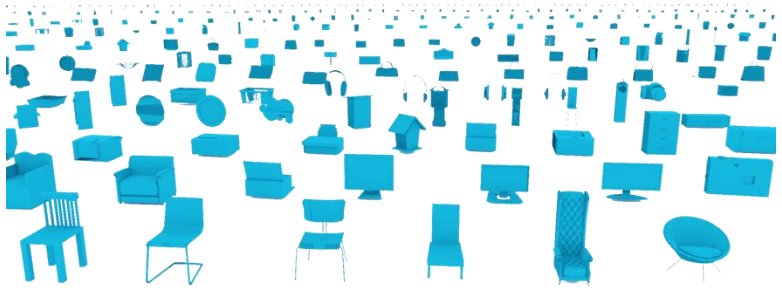
Relation-aware
NBV generation

CAD Recomposition

Oriented bounding boxes



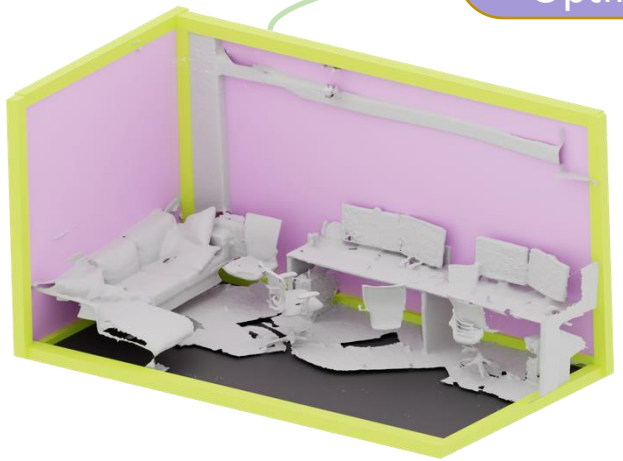
CAD dataset



CAD recomposition

Relation-guided Optimization

Geometry-aligned CAD Retrieval



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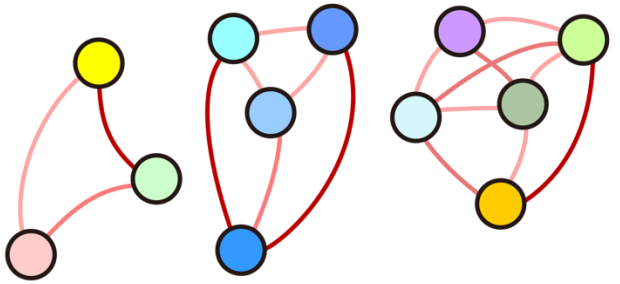
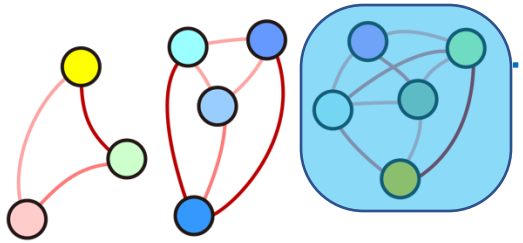


Predicted relation

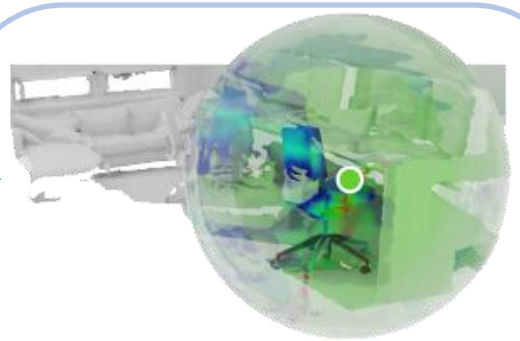
NBV Generation

CAD recomposition

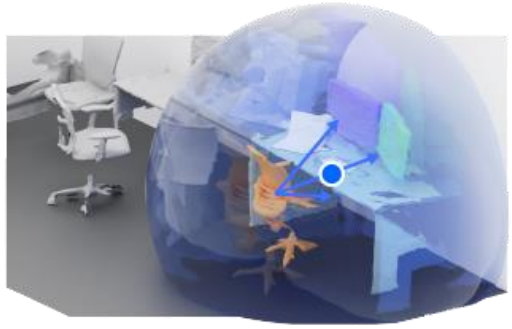


Predicted relation

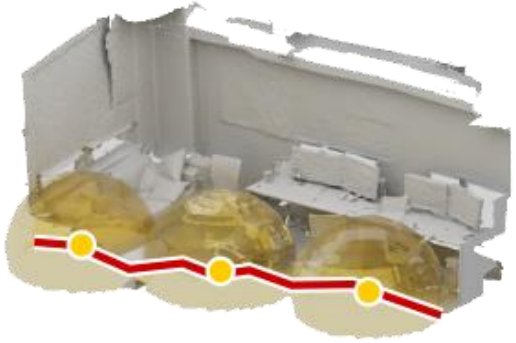
2D occupancy grid



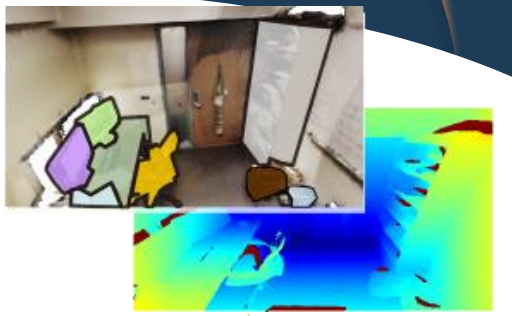
Object ROI

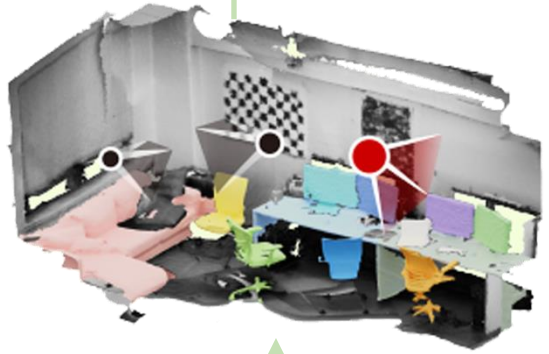


Relation ROI



Frontier ROI





Candidate Viewpoint Generation

Fused ROI

Overview

Info update

Relation-guided
scene CAD recomposition

Scanned RGB-D observation

Relation-aware
NBV generation

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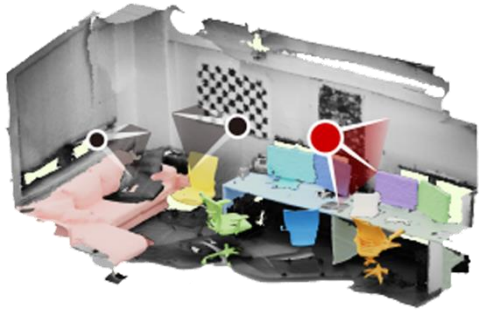

Relation-aware
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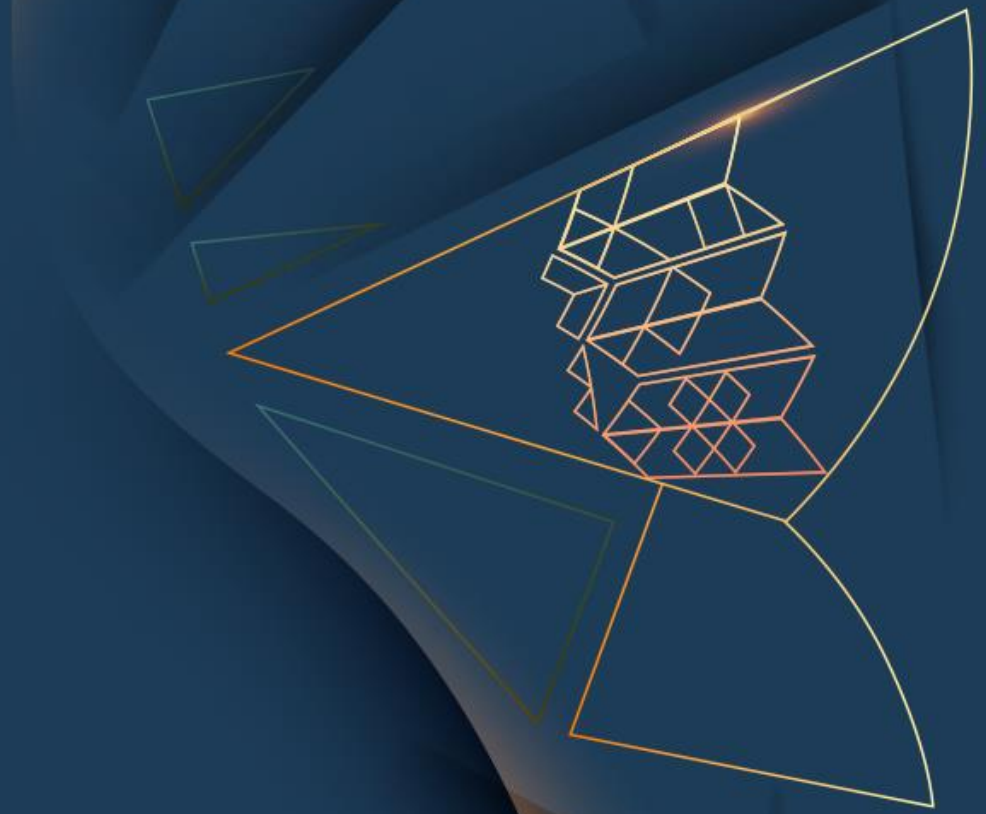
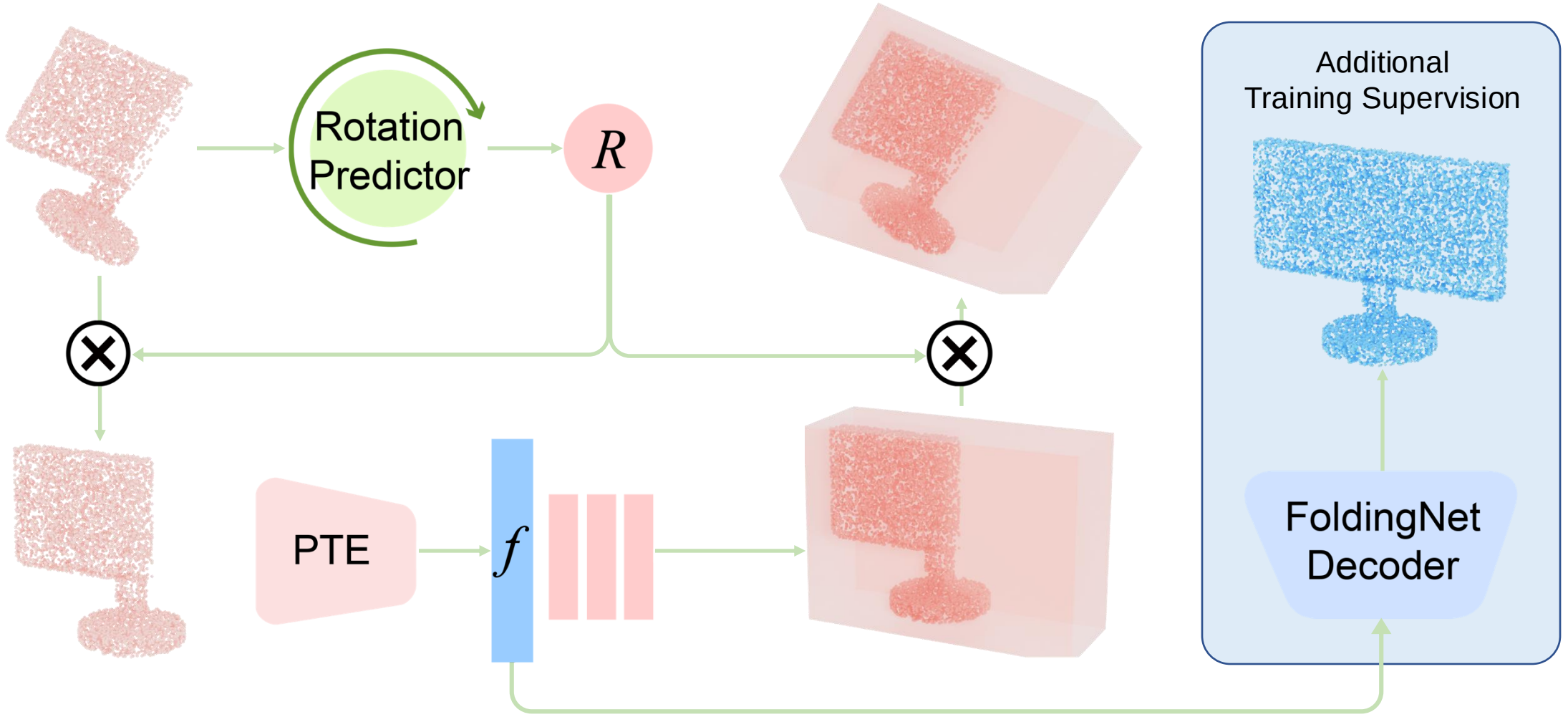
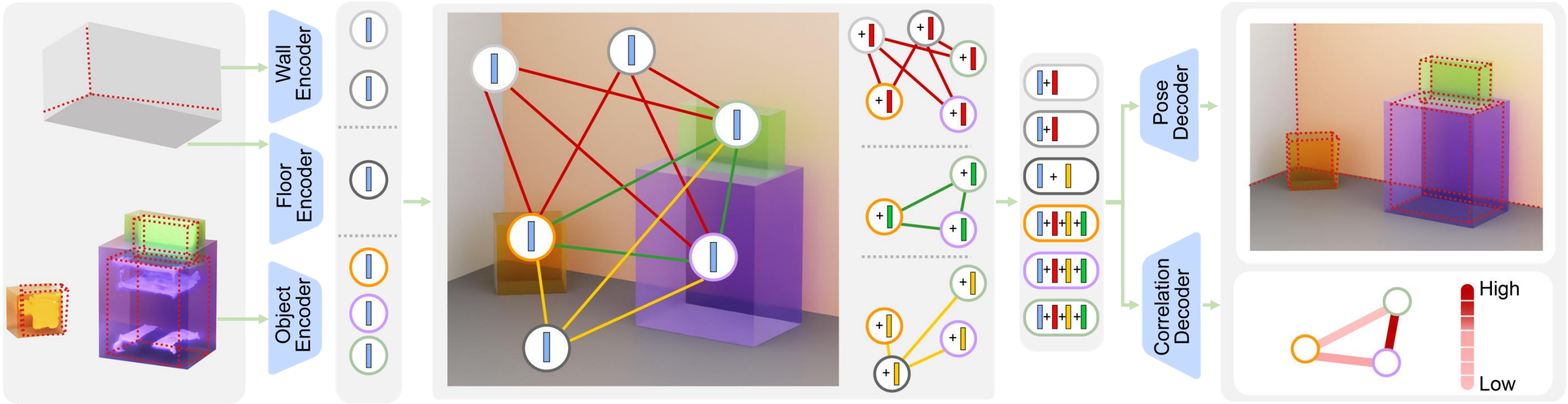


Details

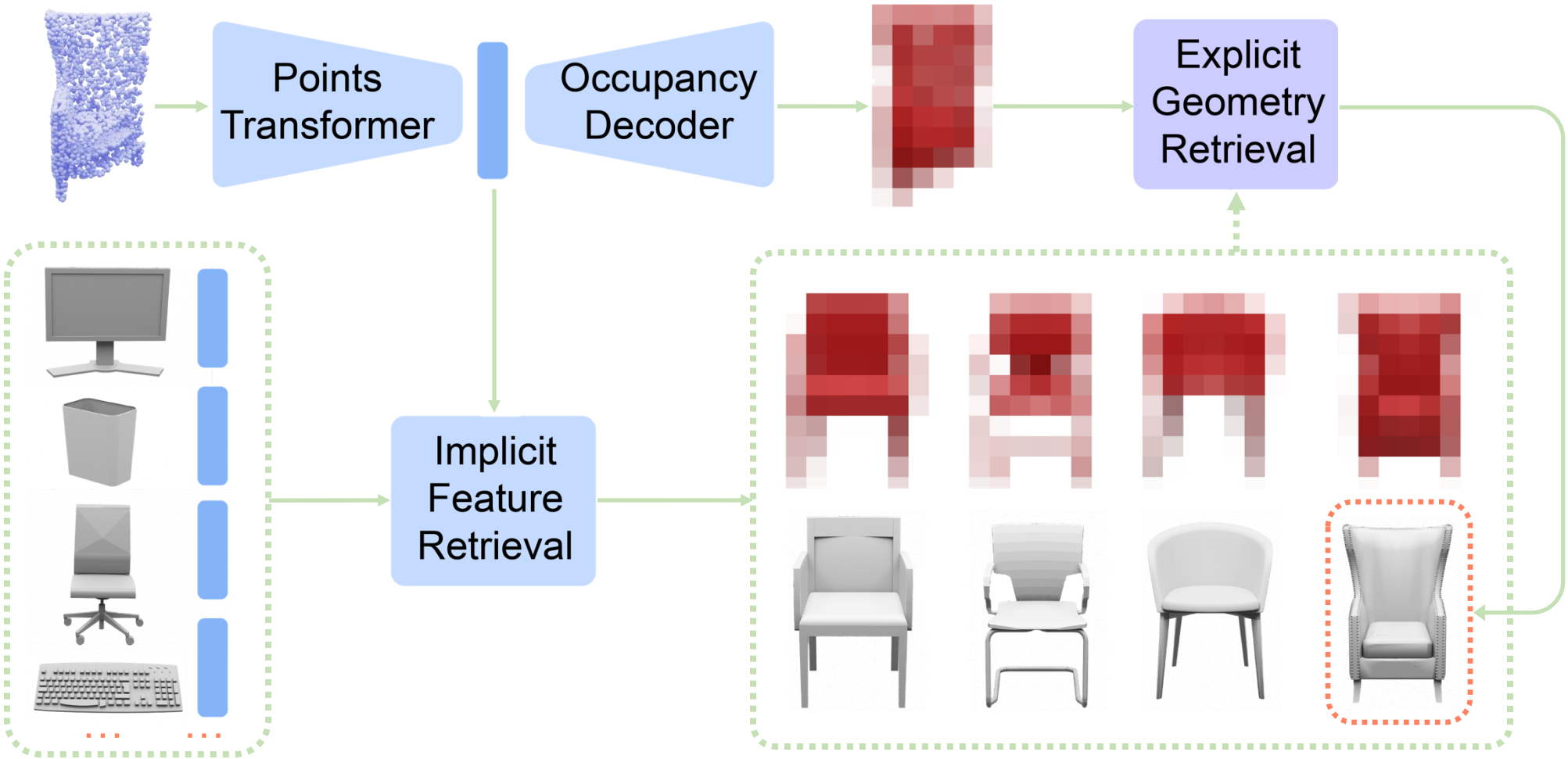
Detail 1 : Object Pose Estimation



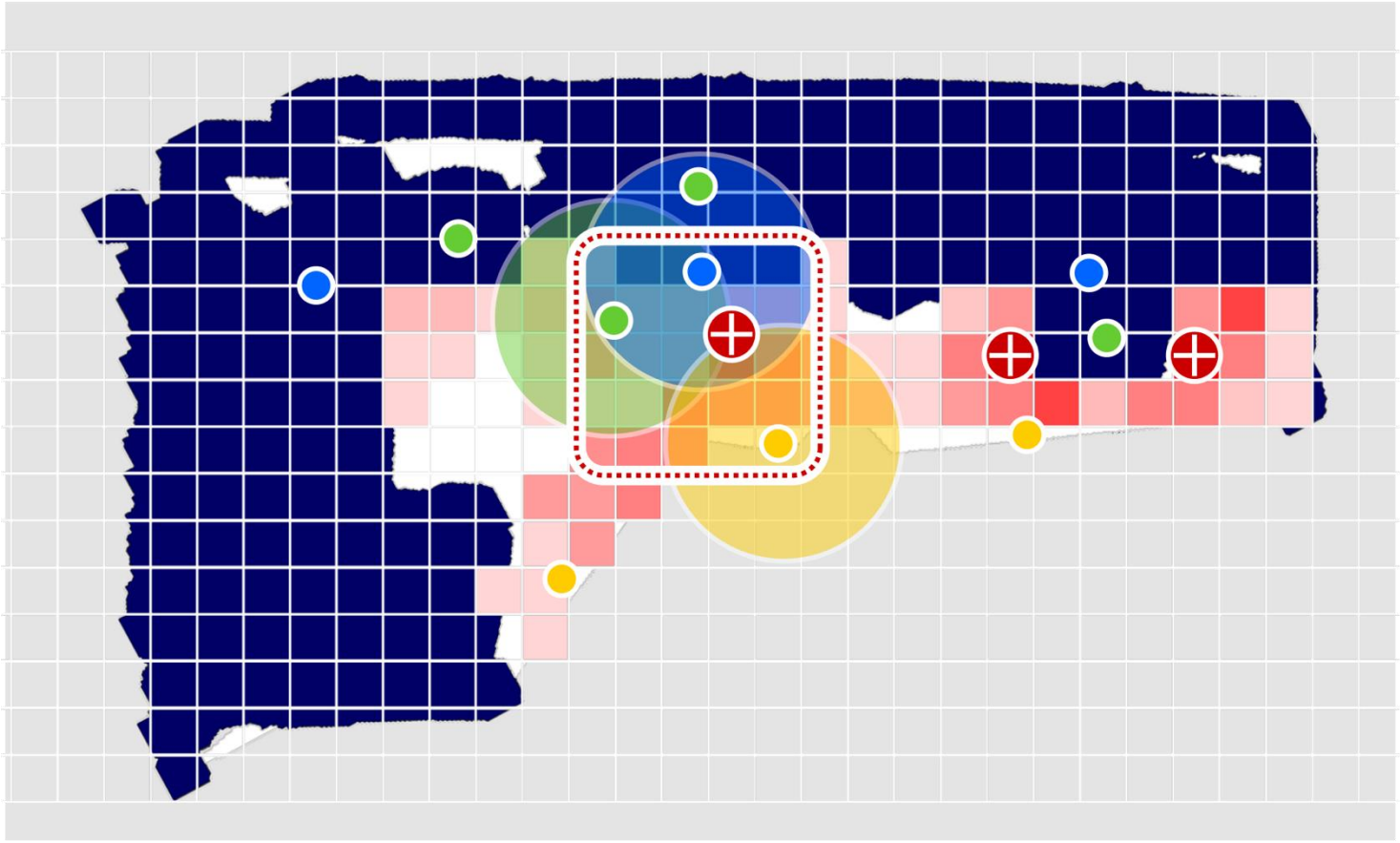
Detail 2 : Relation-guided Optimization

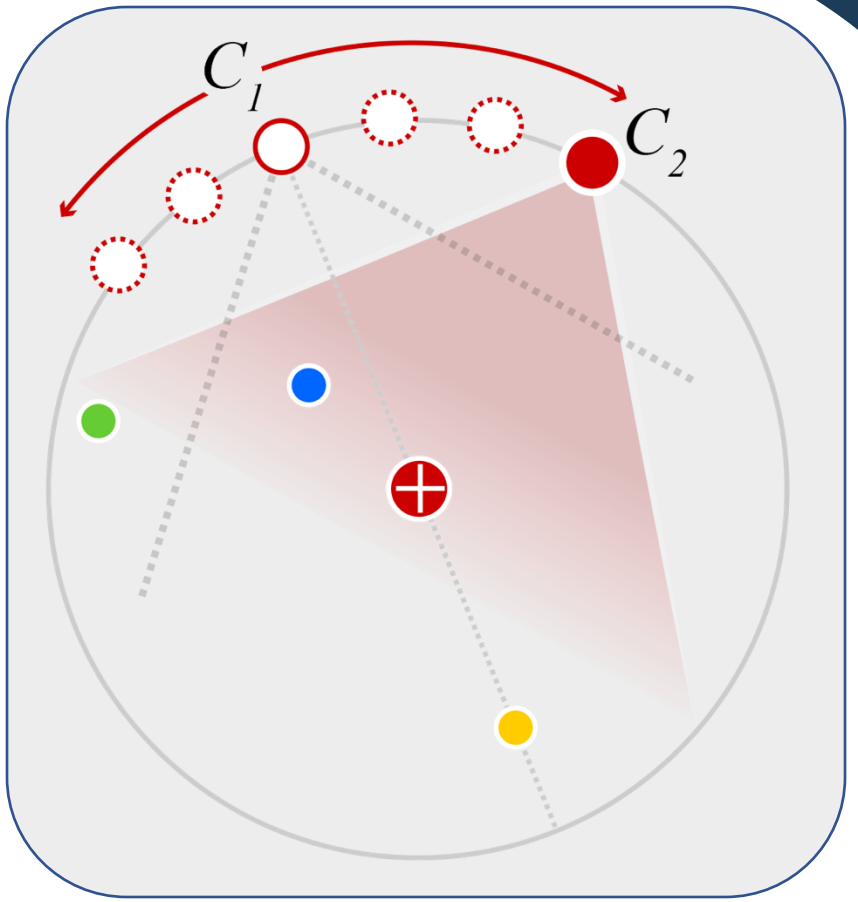


Detail 3 : Geometry-aligned CAD Retrieval



Detail 4 : Candidate Viewpoint Generation





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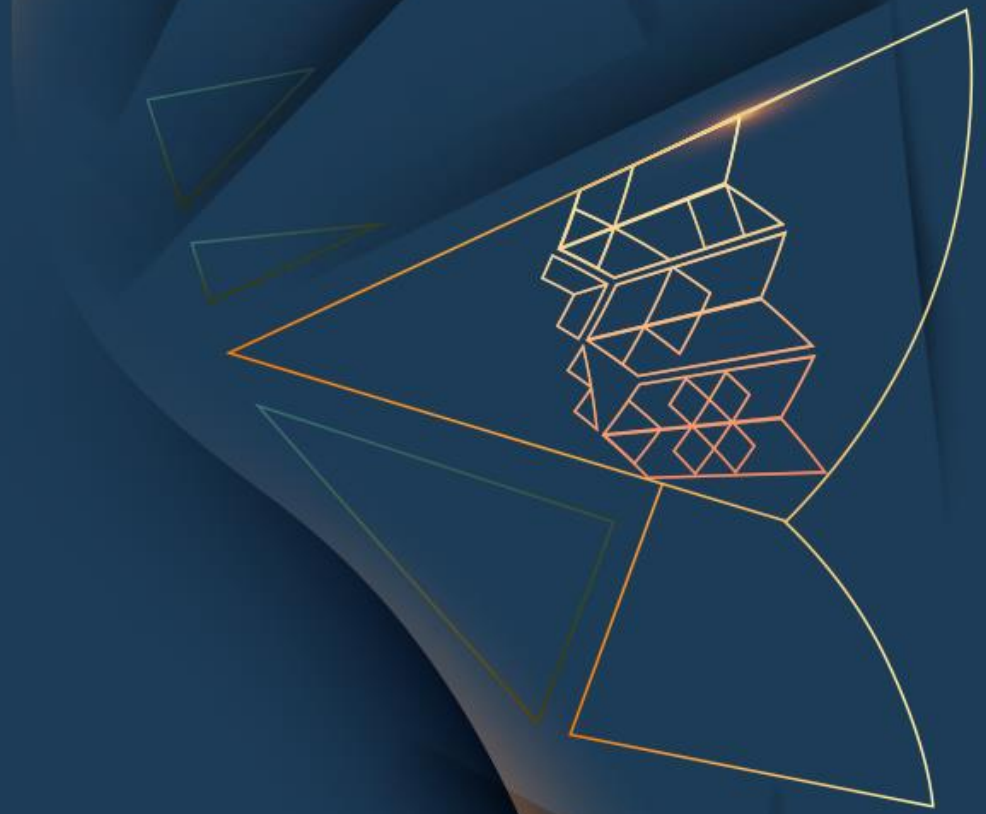
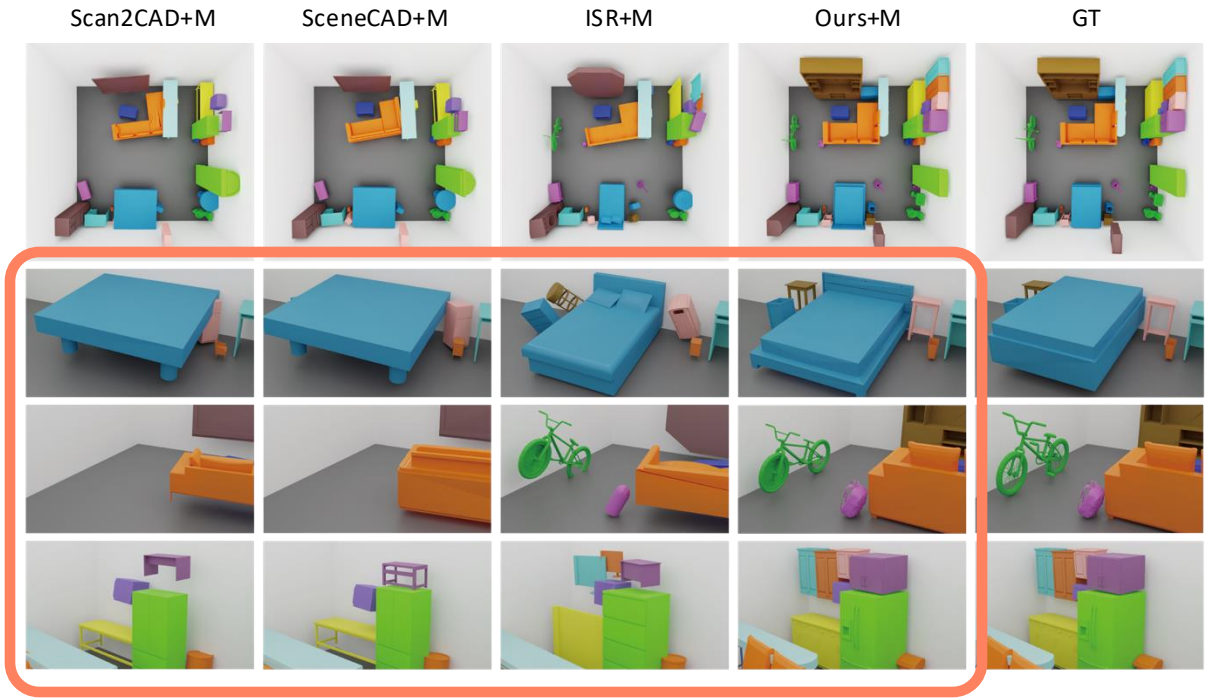


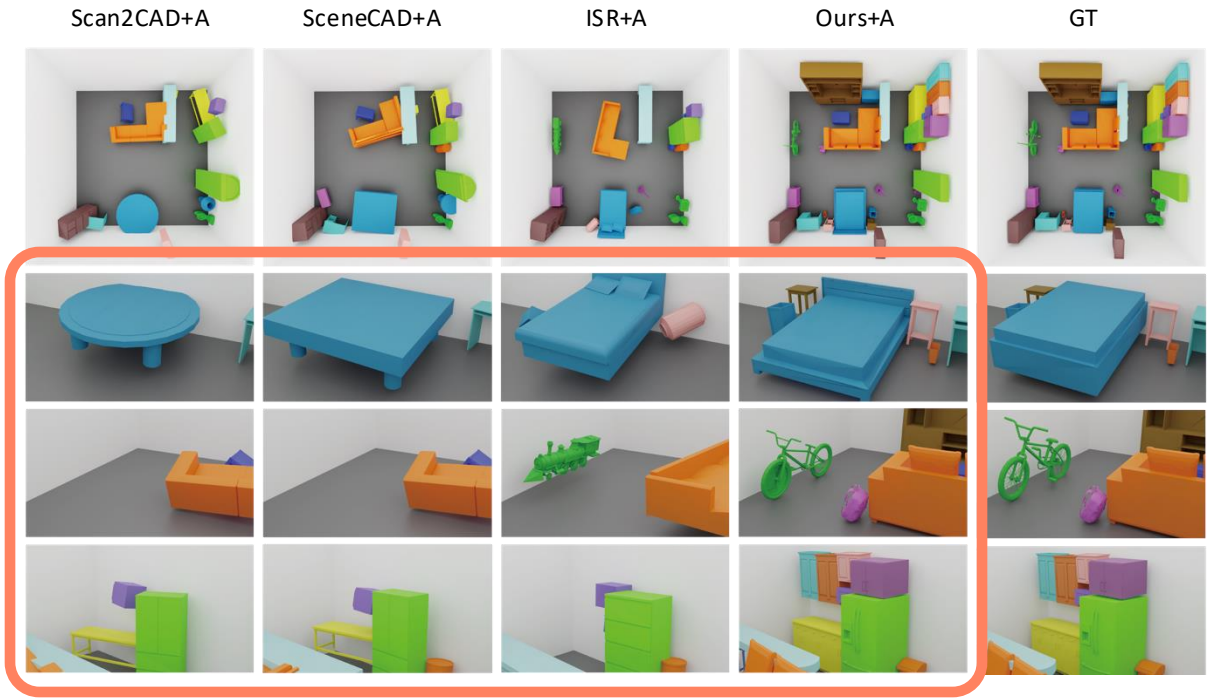
Evaluations

Offline comparison

- TC: Time Consumption
- SC: Storage Consumption
- CA: Class Accuracy
- PA: Pose Accuracy
- PE: Pose Error
- GE: Geometry Error

#Frame	Method	TC ↓	SC ↓	CA ↑	PA ↑	PE ↓	GE ↓
Manual (94)	Scan2CAD	10.373	20.814	0.484	0.307	0.445	0.049
	SceneCAD	11.763	23.624	0.491	0.524	0.442	0.042
	ISR	3.118	26.192	0.412	0.496	0.440	0.024
	Ours	**2.940**	**5.325**	**0.552**	**0.628**	**0.357**	**0.011**
Auto (24)	Scan2CAD	9.854	13.482	0.467	0.284	0.509	0.054
	SceneCAD	11.072	14.526	0.483	0.492	0.515	0.046
	ISR	0.868	15.517	0.391	0.473	0.520	0.026
	Ours	**0.791**	**5.271**	**0.562**	**0.636**	**0.352**	**0.010**



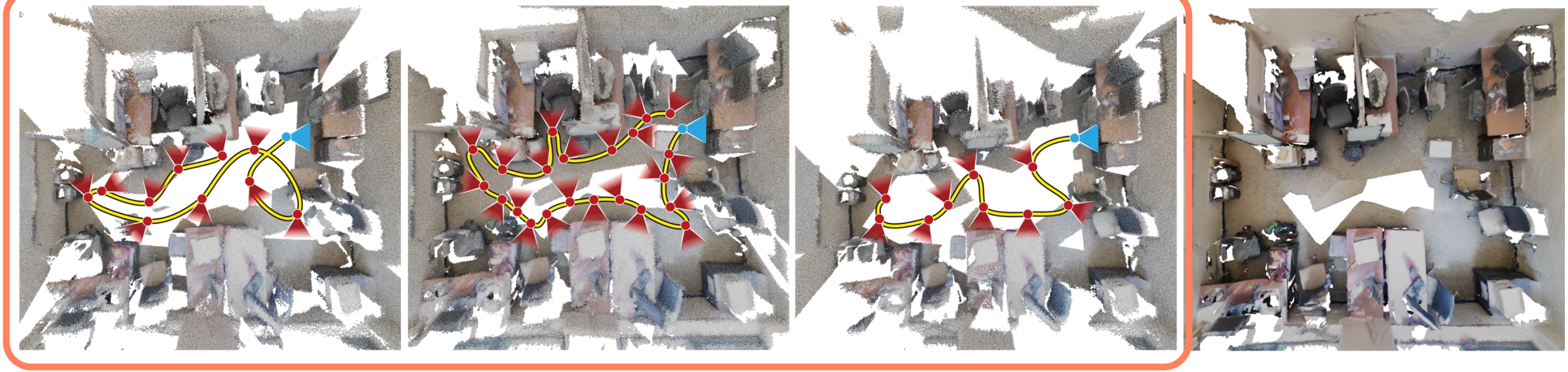


Online Comparison

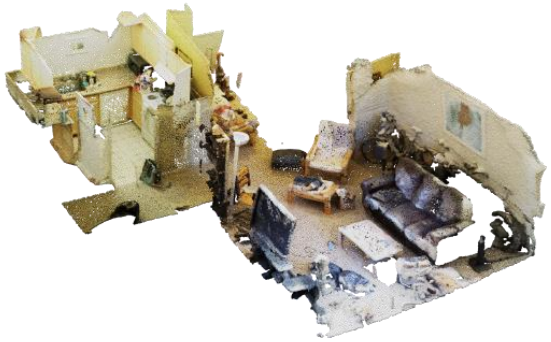
- DC: Distance Consumption
- TC: Time Consumption
- SC: Storage Consumption
- CA: Class Accuracy
- PA: Pose Accuracy
- PE: Pose Error
- GE: Geometry Error

Method	DC ↓	TC ↓	#NBV ↓	SC ↓	CA ↑	PA ↑	PE ↓	GE ↓
ROCA+RelNBV	45.533	7.116	27.675	8.708	0.482	0.342	0.705	0.387
RelCAD+AsyncScan	47.725	9.973	32.284	48.298	0.558	**0.636**	**0.352**	**0.010**
Ours (RelCAD+RelNBV)	**37.806**	**6.045**	**23.646**	**5.271**	**0.562**	**0.636**	**0.352**	**0.010**

ROCA+RelNBV | RelCAD+AsyncScan | Ours(RelCAD+RelNBV) | GT

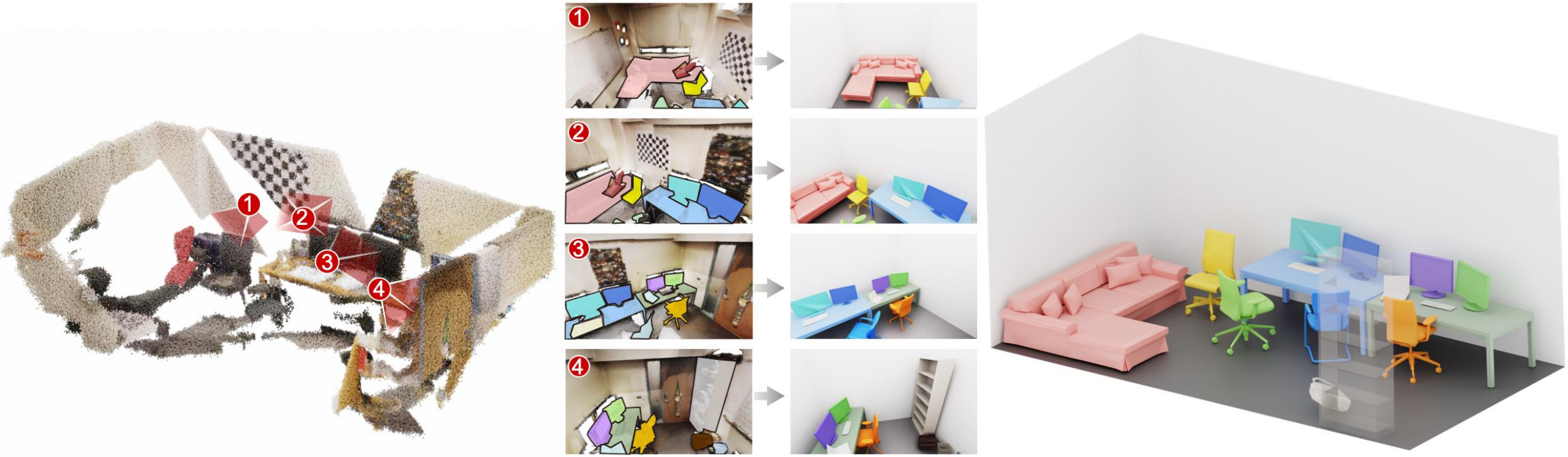


More results



Conclusion

Online Scene CAD Recomposition via Autonomous Scanning



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Supplementary materials and code are available:

https://565353780.github.io/AutoScan2CAD/

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Thank you for attention!