



China3DV-2025

3D Gaussian Spalting: Case Studies

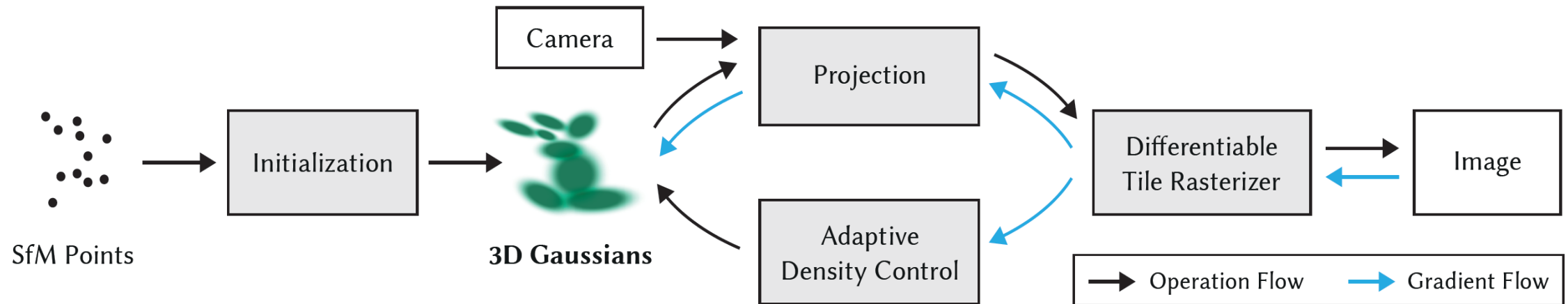
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3D Gaussian Splatting

- Leveraging 3D point clouds to record 3D structure and textures at the same time.

Point = \langle 3D Position, Rotation, 3D scale, SH Coefs \rangle

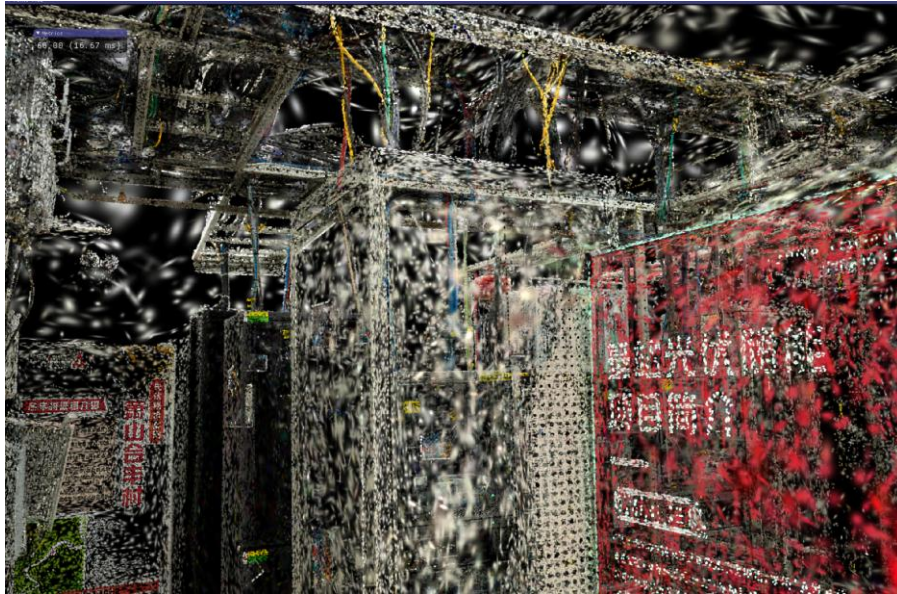


Fast training and rendering speed but more dependent on geometry

3D Gaussian Splatting

- It is mainly designed for light field rendering. Each point can be viewed as **a point sample of a radiance field**.

Gaussian Points



Point samples

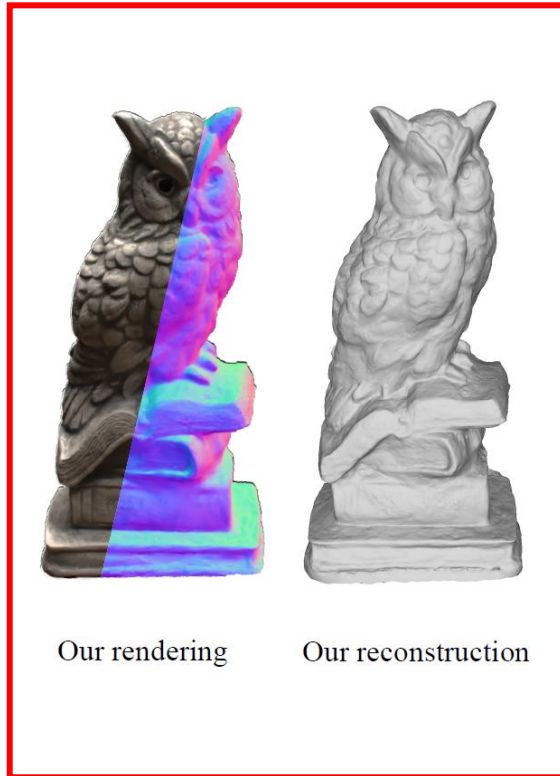


Rendering Result

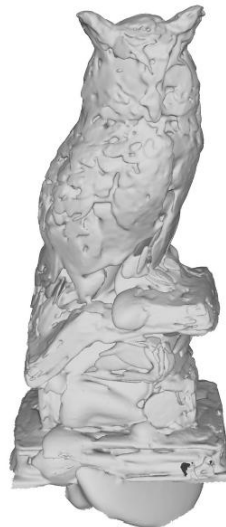
Reconstructed ray colors

Gaussian Surfels

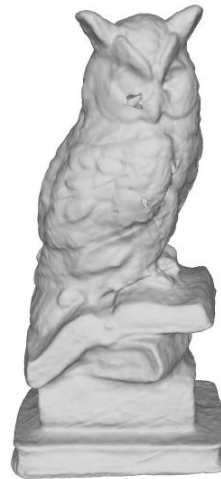
- Treat the 3DGS as **point samples of an object surface** to combine the advantages of 3DGS and the surface alignment property of surfels.



3D Gaussian
[Kerbl et al. 2023]



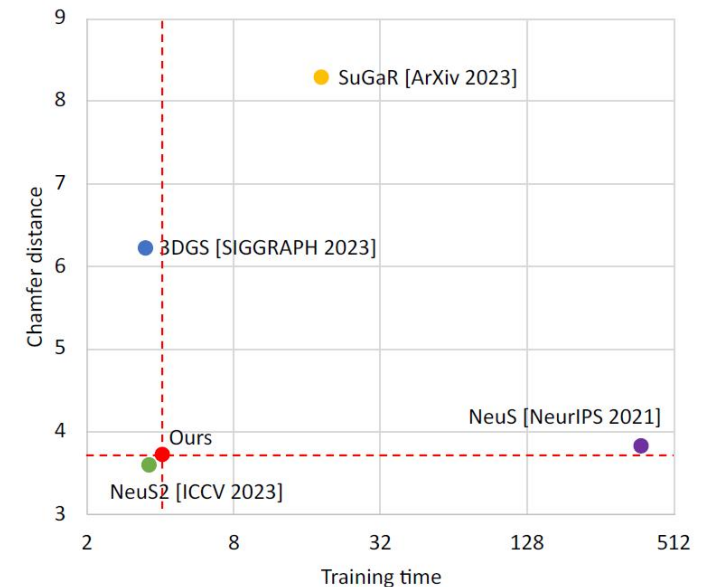
SuGaR
[Guédon et al. 2023]



NeuS2
[Wang et al. 2023]

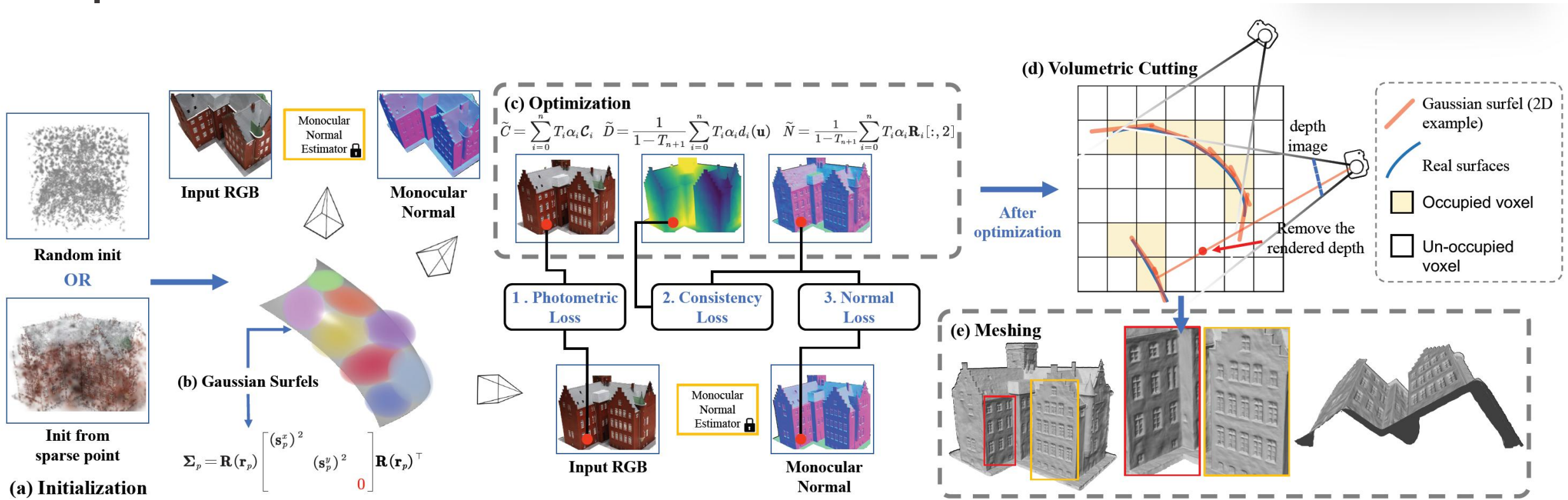


NeuS
[Wang et al. 2021]



Gaussian Surfels

- Modified point representation:** set the **z scale to be zero** which enforce the local z axis to be the normal, which flattening the 3D points



- ✓ Improve the surface alignments
- ✓ Mitigate shape-radiance ambiguity

Gaussian Surfels

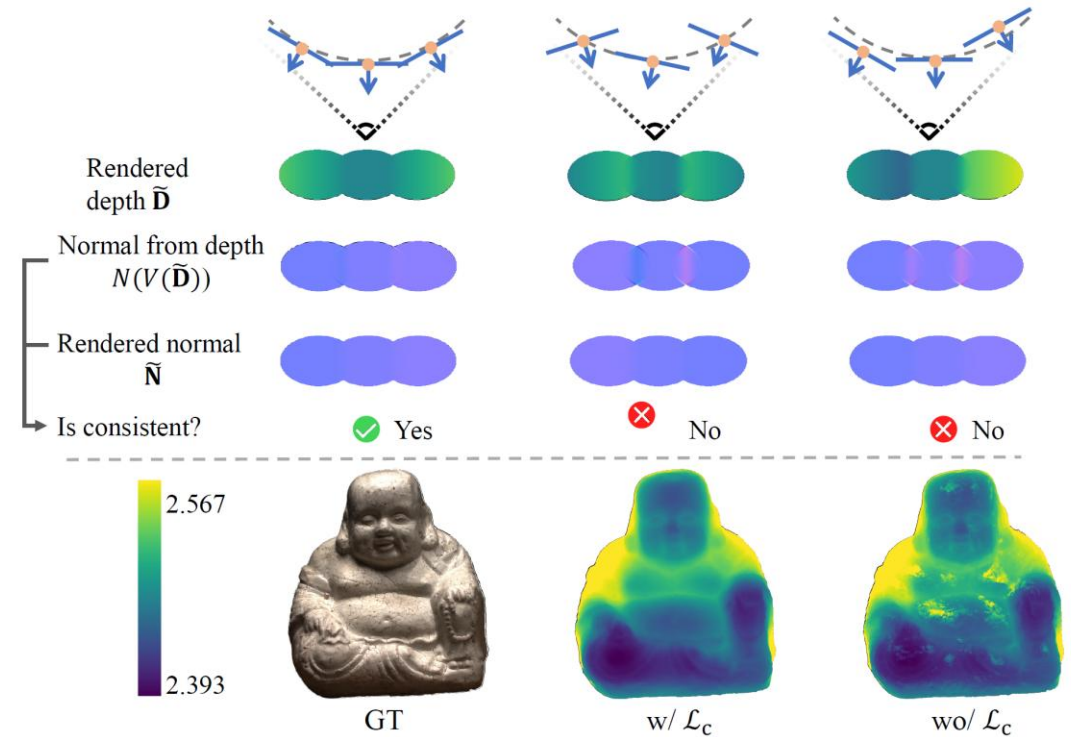
- Solve the derivative issues: the derivative of the photometric loss to the z axis of the rotation matrix will be 0 for Gaussian surfels.

Therefore, we design depth-normal consistency loss:

$$\mathcal{L}_c = L_1(\tilde{\mathbf{N}}, N(V(\tilde{\mathbf{D}}))).$$

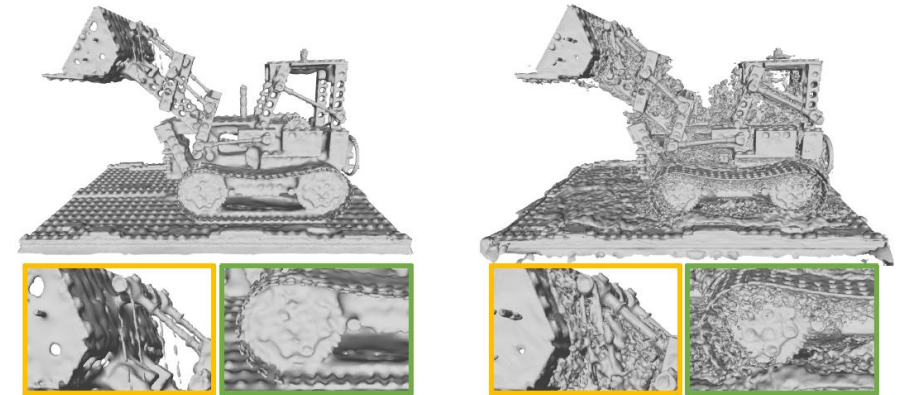
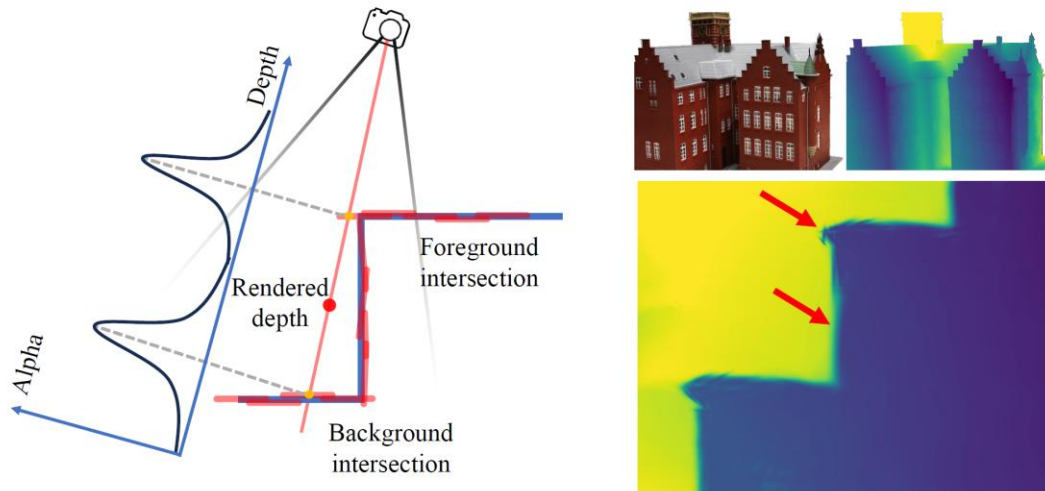
Normal Rendered using local Z axis.

Normal computed from the rendered depth map



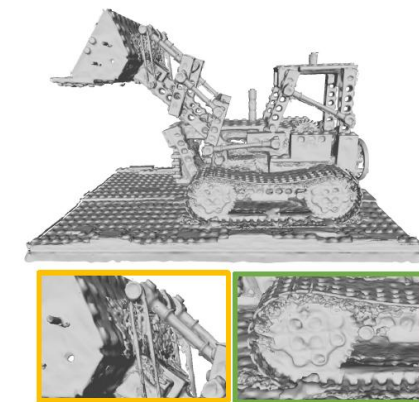
Gaussian Surfels

- Poisson surface Meshing: volumetric cutting to avoid erroneous depth values

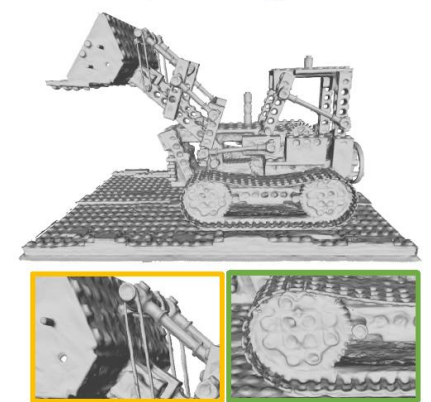


(a) Meshing with Gaussian centers

(b) Depth fusion & meshing (wo/ cutting)



(c) Depth fusion & meshing (pixel-level median)

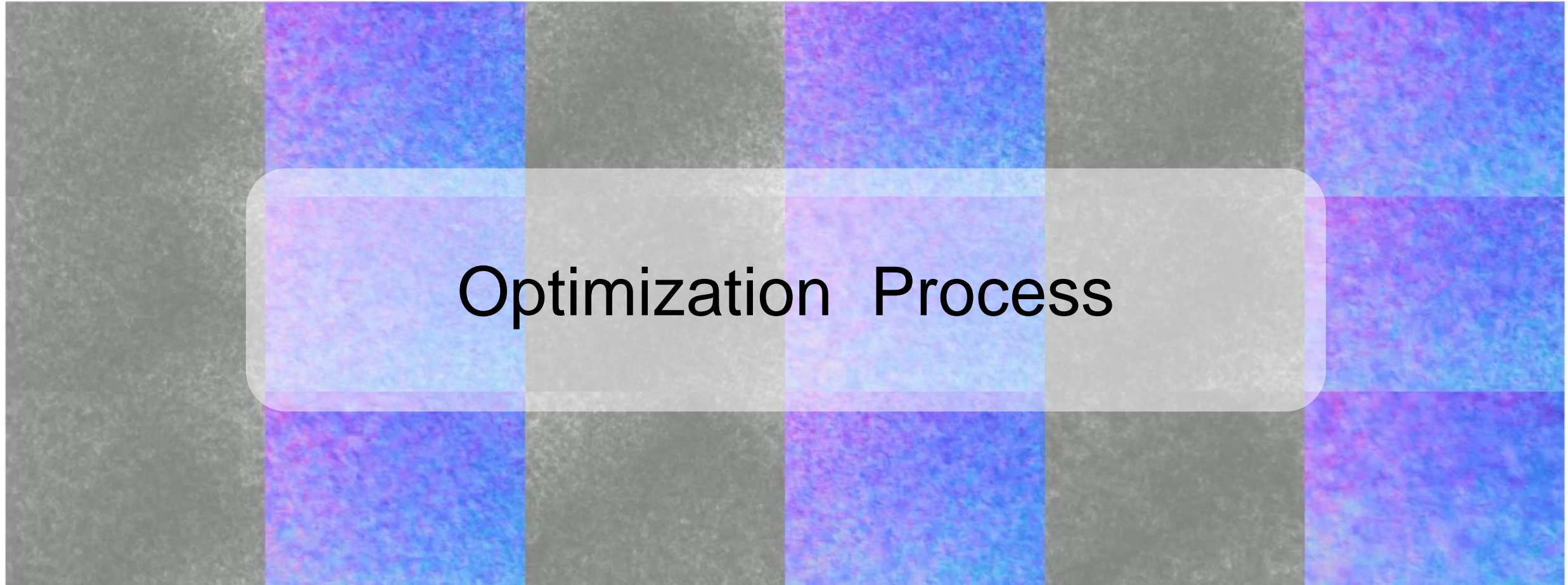


(d) Depth fusion & meshing (volumetric cutting)

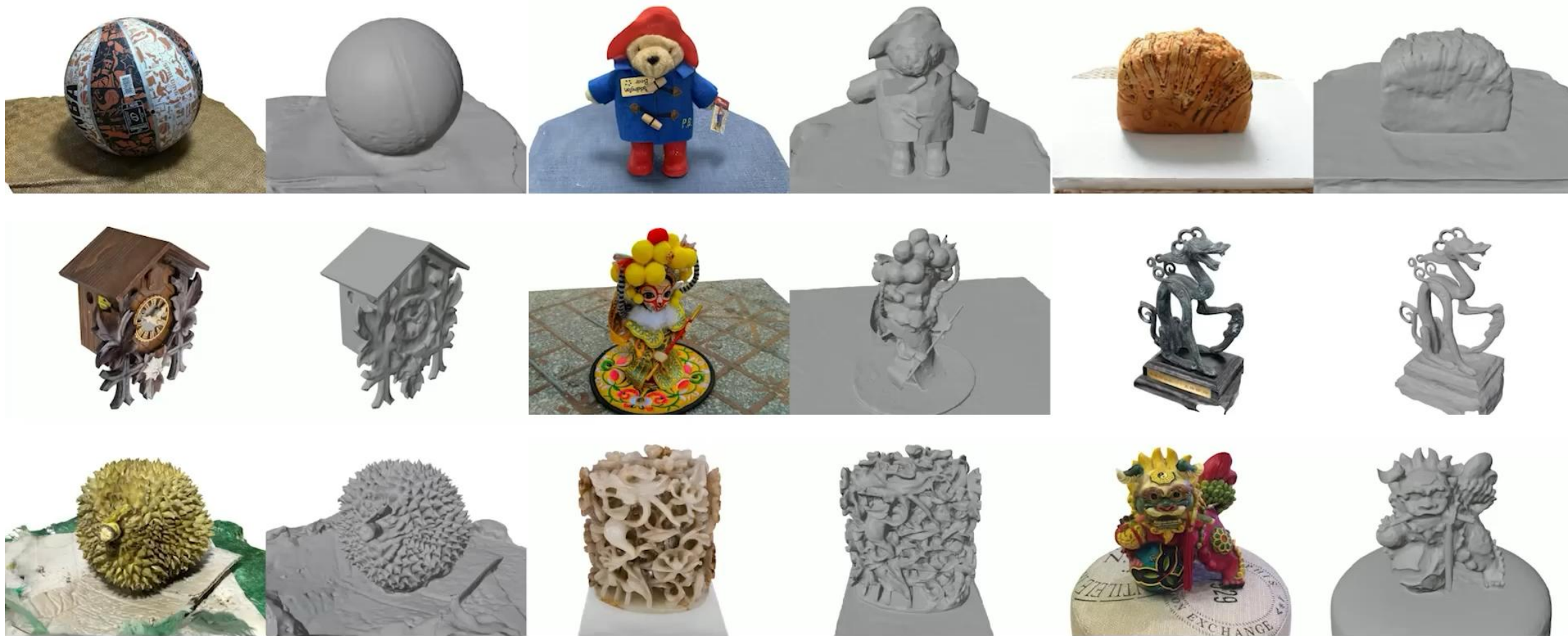
Fig. 5. An example of error in the rendered depth. The complex distribution of Gaussian surfels after optimization makes it difficult to remove outlier Gaussian points along each ray by discarding points far from median or alpha-weighted mean.

Optimization with Random Initialization

- Trained for ~6mins from random initialization on DTU dataset

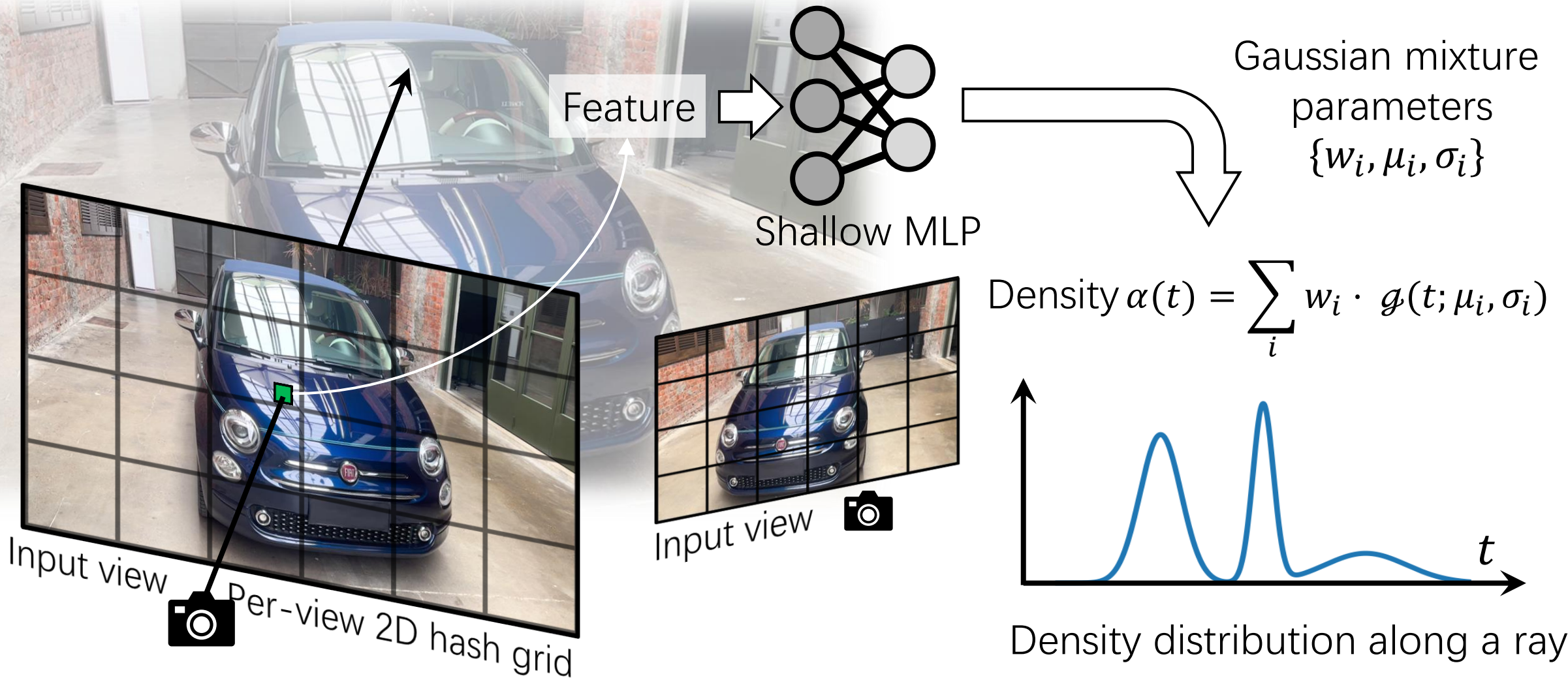


More Results



Sample and Reconstruction – Local Gaussian Fields

- Build Gaussian fields at each ray for unstructured light field rendering



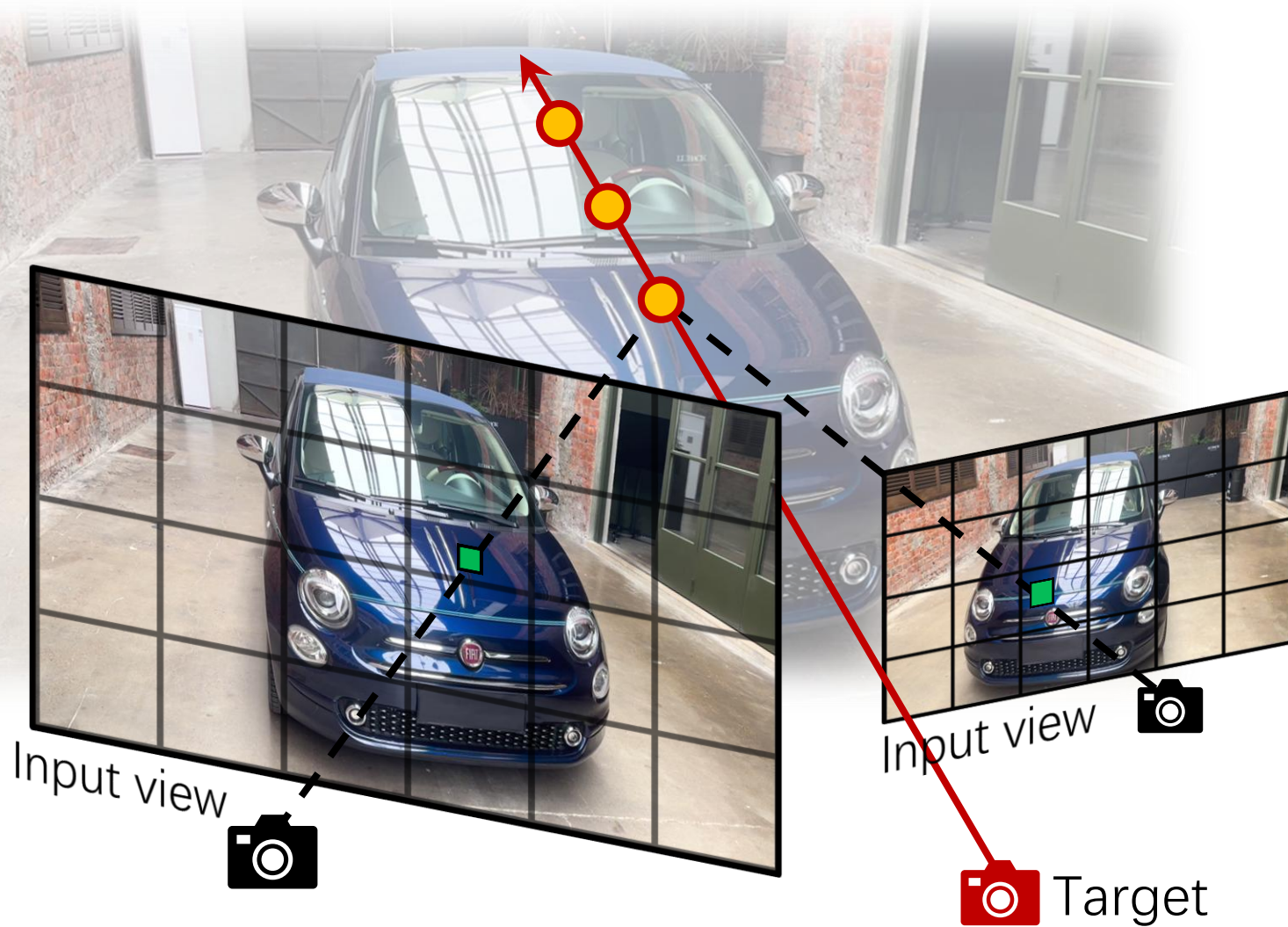
Sample and Reconstruction – Local Gaussian Fields

Given a target view point, how to render?

STEP1 Sample points along a ray casted from a pixel

STEP2 Backward projection to obtain (Color, density, visibility)

STEP3 Multi-view fusion (neural weight)



Sample and Reconstruction – Local Gaussian Fields

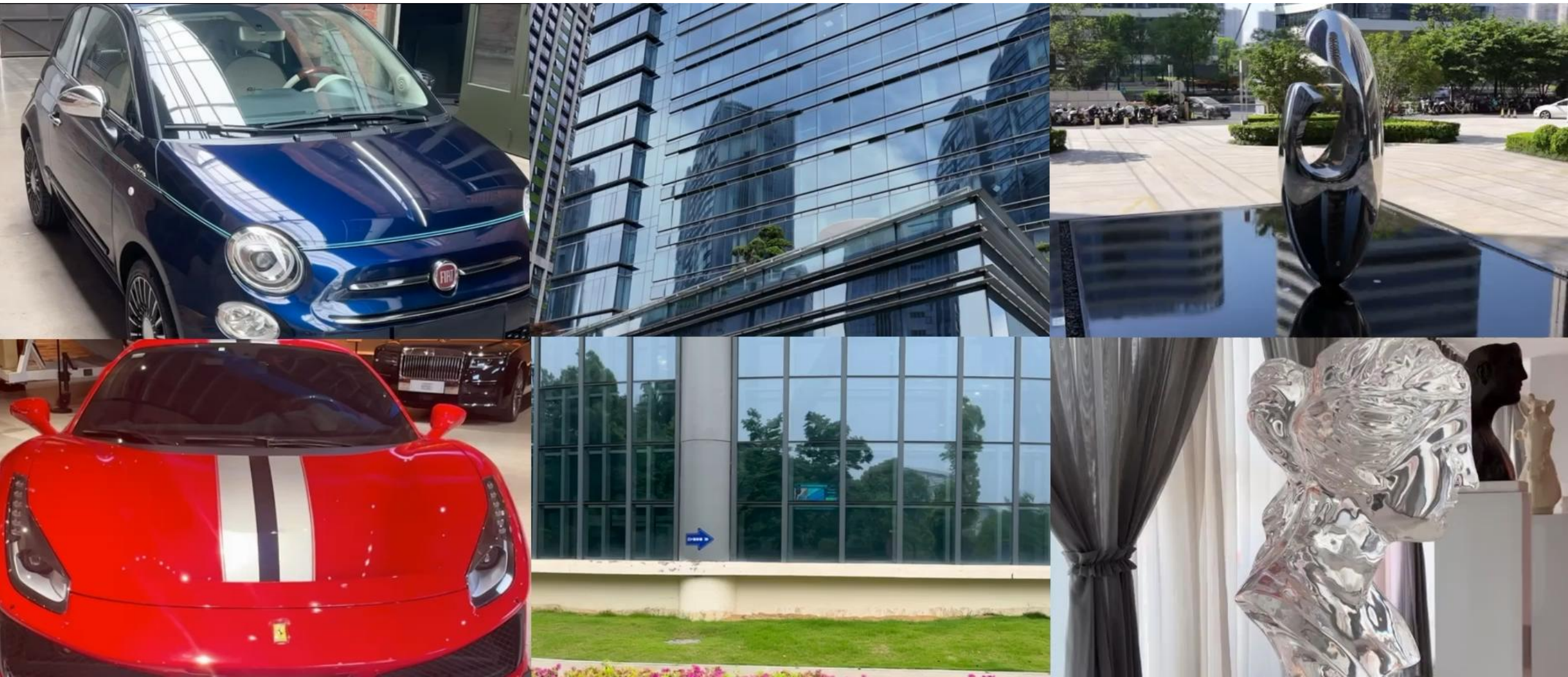


Ours

3DGS [Kerbl et al. 2023]

Ref-NeRF [Verbin et al. 2022]

Sample and Reconstruction – Local Gaussian Fields



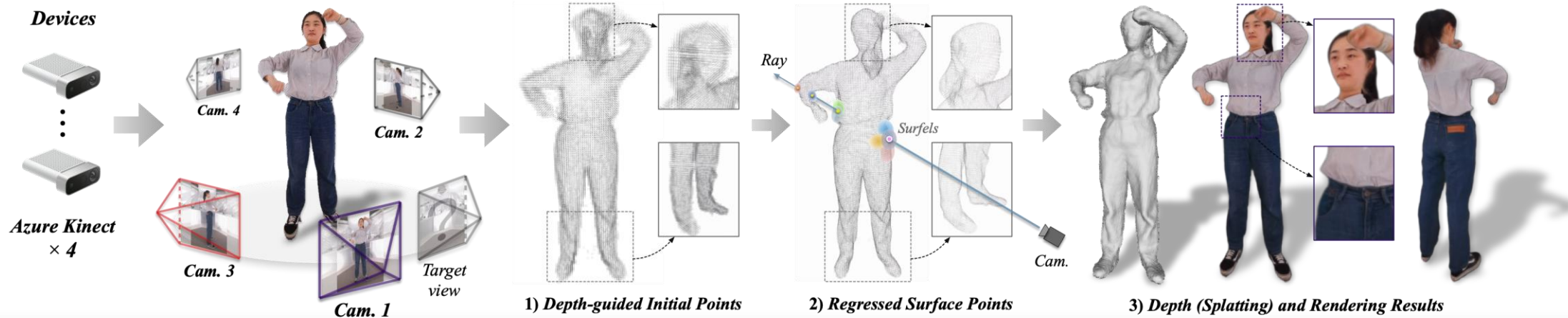
Our Results from Novel Views (Unseen Performers)

Live Rendering



Capture Setting (RGBD × 4)

Point Cloud and Novel-view Rendering



GAUSSIAN SURFEL SPLATTING FOR LIVE HUMAN PERFORMANCE

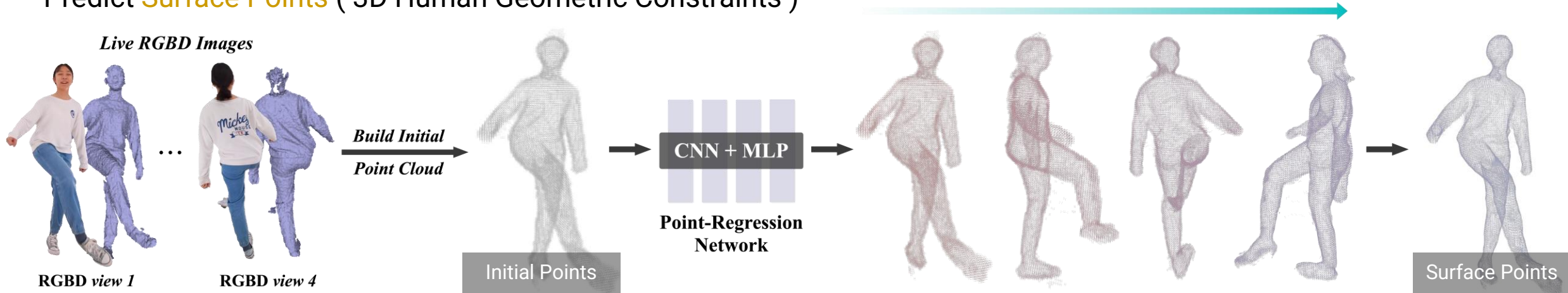
CAPTURE

Zheng Dong, Ke Xu, Yaoan Gao, Hujun Bao, Weiwei Xu, Rynson W.H. Lau

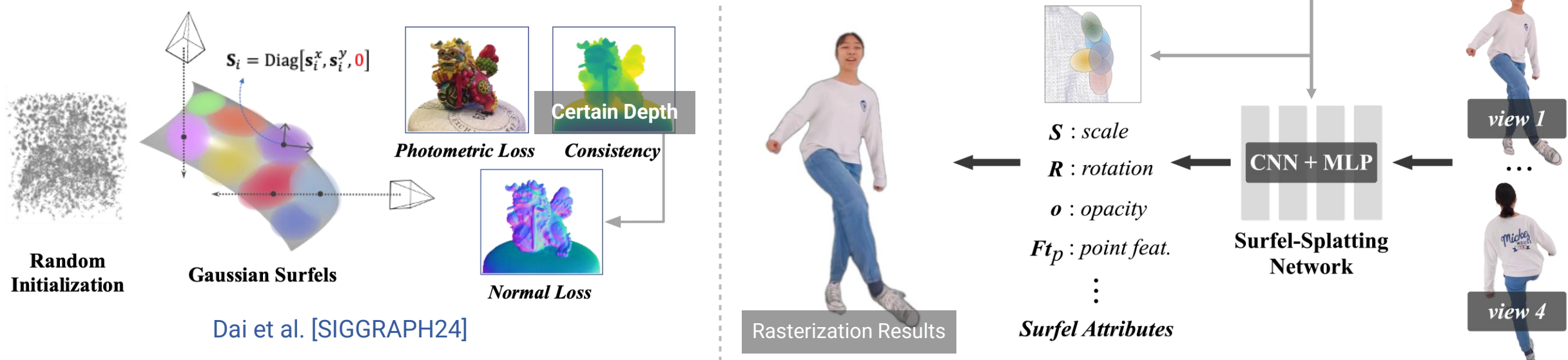


Pipeline

- Predict **Surface Points** (3D Human Geometric Constraints)



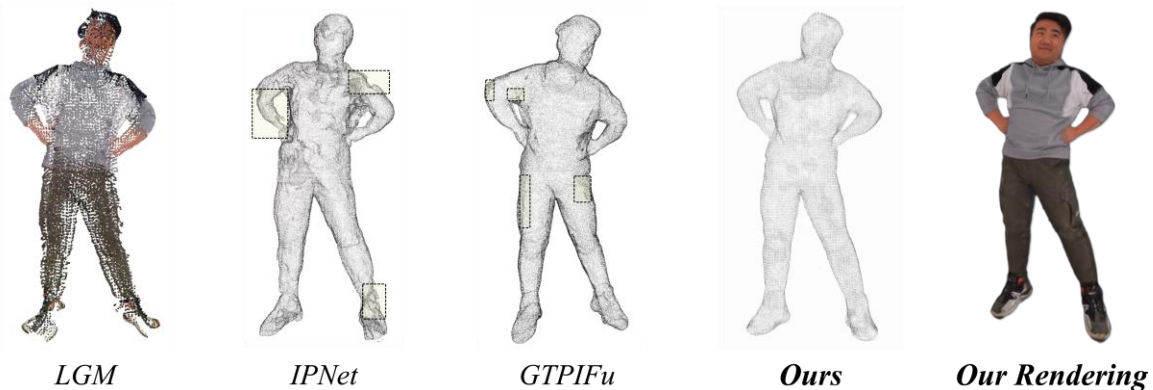
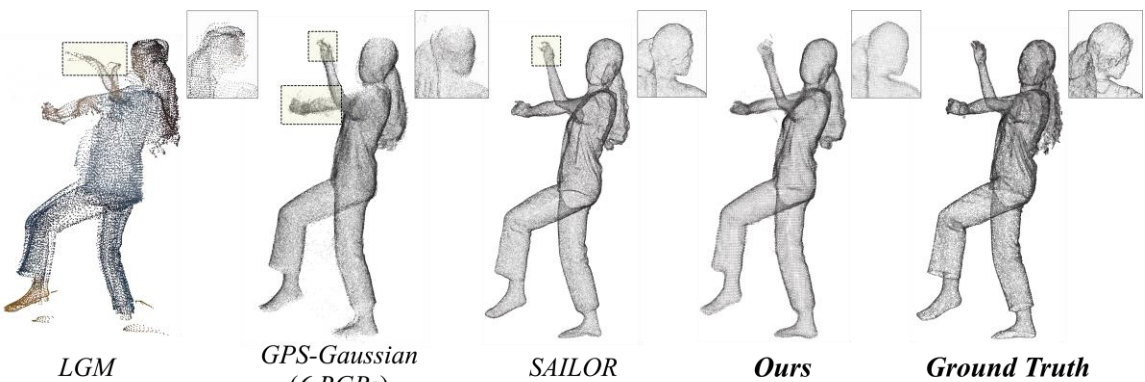
- Use 2D Gaussian Surfels (Encode Human Radiance Field with Color / Geometric Supervisions)



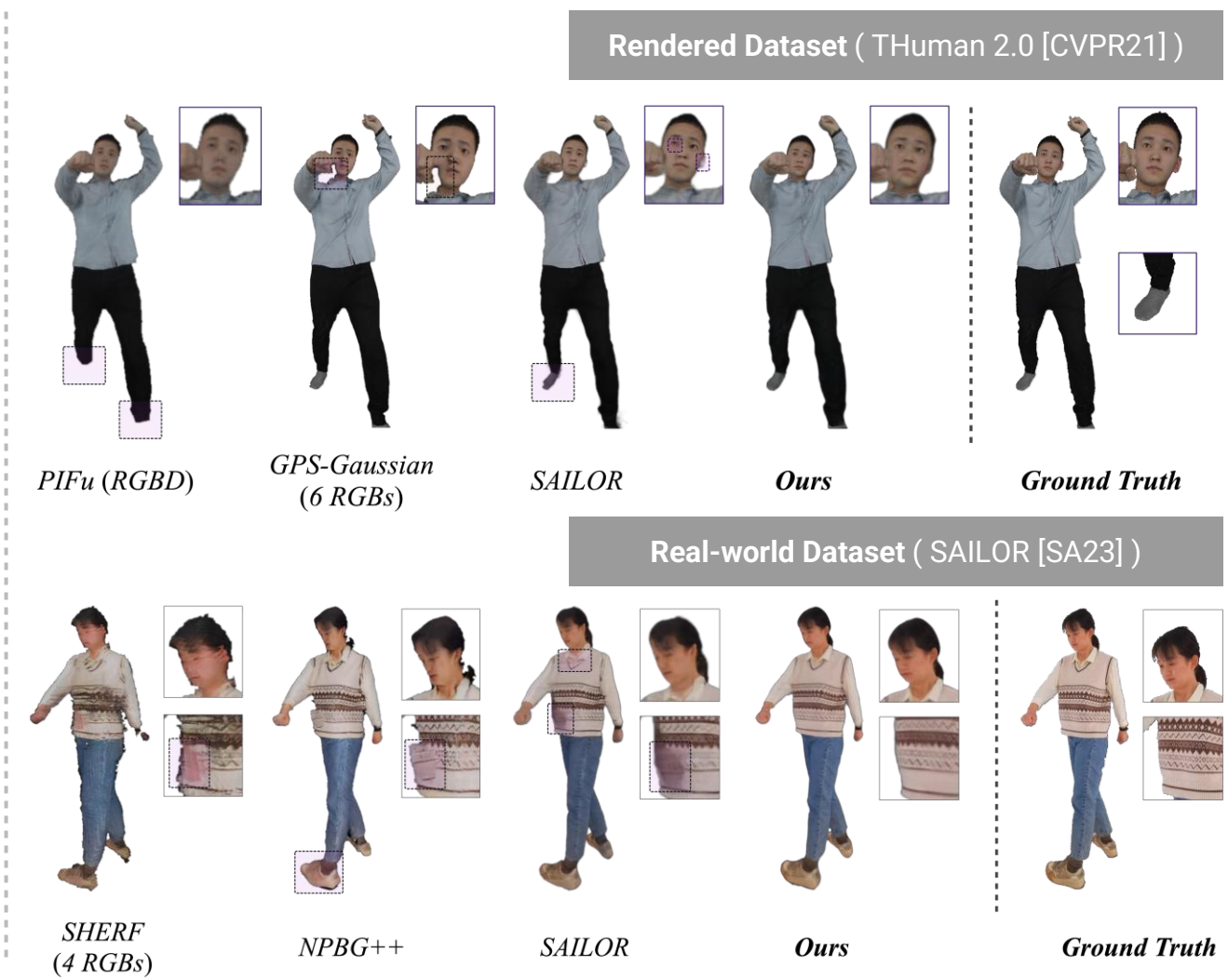
Comparisons

- Geometric Comparisons (Surface Points / Mesh Vertex)

Index	Methods (THuman2.0 Dataset [Yu et al. 2021b])				
	GPS-Gaussian (N=6)	LGM	GTPIFu (N=4)	SAILOR	Ours
Chamfer $\times 10^{-2}$ ↓	0.982	3.996	0.922	0.975	0.801
P2S $\times 10^{-2}$ ↓	0.920	3.942	0.817	0.807	0.715



- Novel-view Rendering Comparisons (4-RGBD Inputs)



Comparisons



More Results



Distributed 3D Scene Reconstruction

- Reconstructing 1 KM2 3D Scene **within 30 minutes** for UAV Data

Import Posed Images



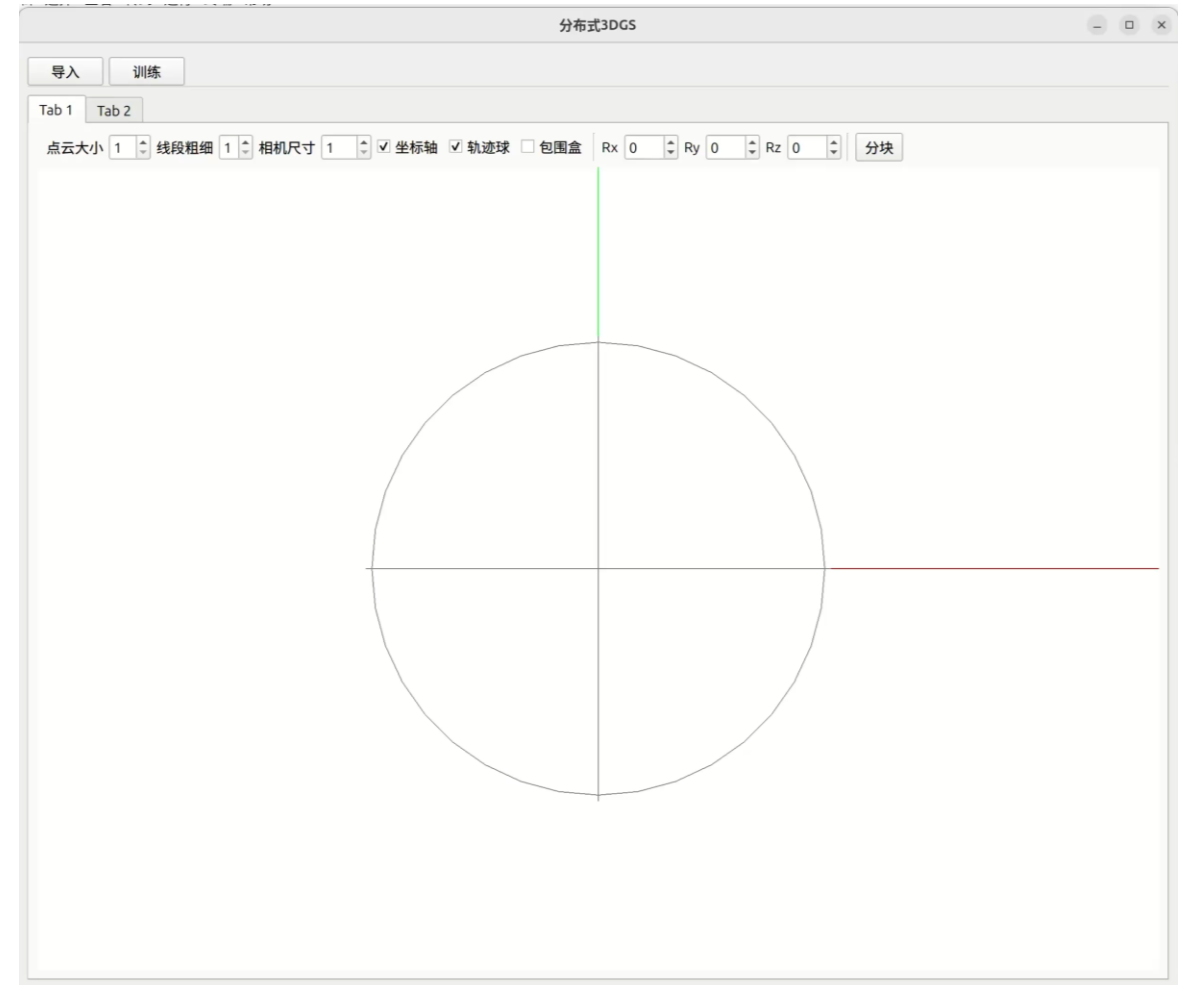
Scene Partition



Distributed Reconstruction



Merging Reconstruction Results



Future Work

- Disentangle reconstructions + HD rendering results.
- From reconstruction to AIGC.

