

3D Gaussian Splatting for Relightable View Synthesis

November 13, 2023

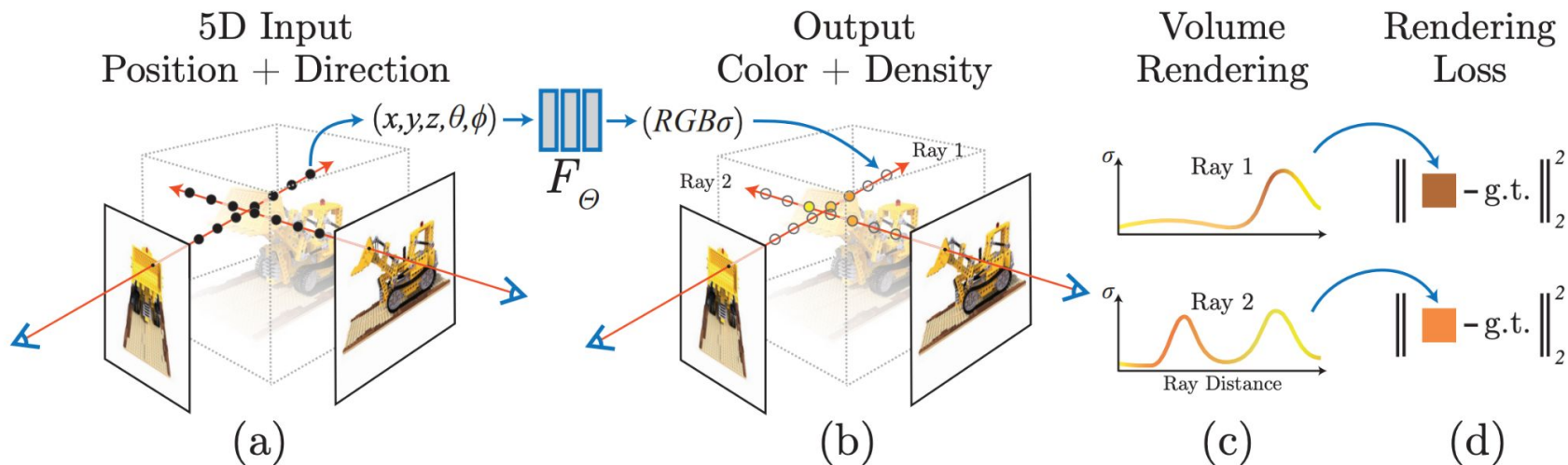
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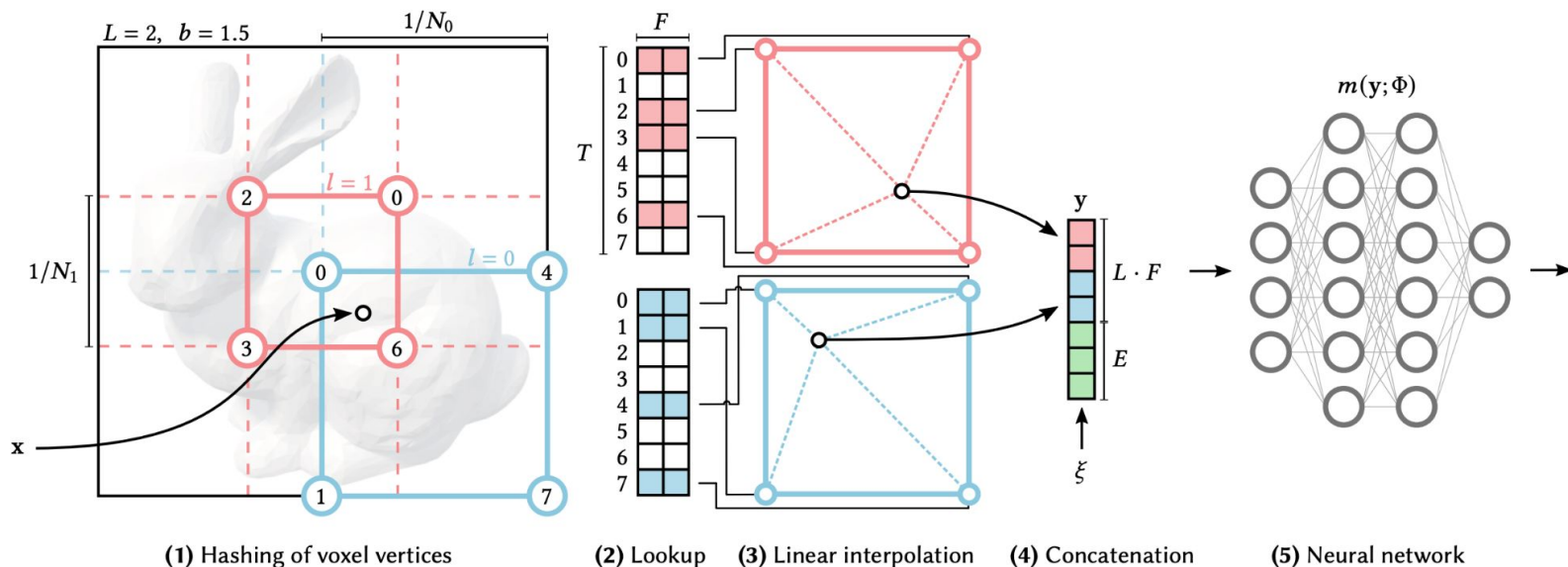
1. Background

NeRF (Neural Radiance Fields)



1. Background

Instant NGP (Instant Neural Graphics Primitives)



1. Background

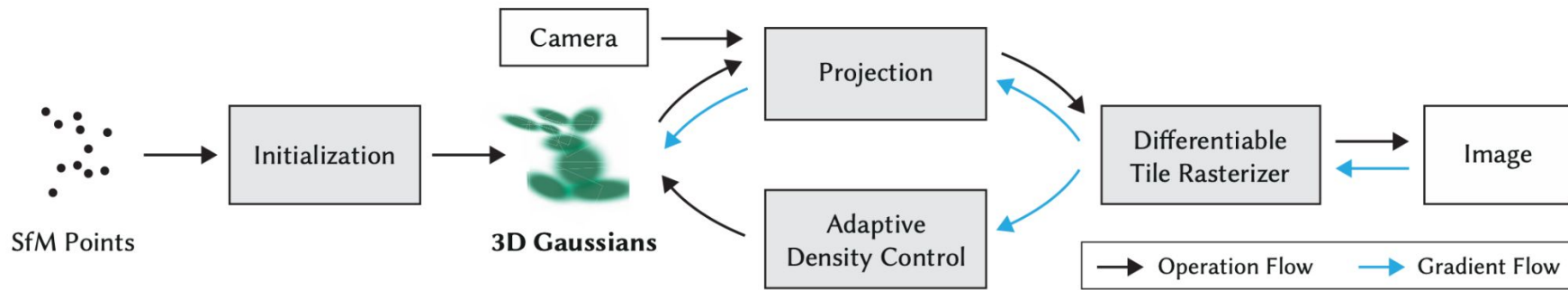
Instant NGP (Instant Neural Graphics Primitives)

	Mic	Ficus	CHAIR	HOTDOG	MATERIALS	DRUMS	SHIP	LEGO	avg.
Ours: Hash (1 s)	26.09	21.30	21.55	21.63	22.07	17.76	20.38	18.83	21.202
Ours: Hash (5 s)	32.60	30.35	30.77	33.42	26.60	23.84	26.38	30.13	29.261
Ours: Hash (15 s)	34.76	32.26	32.95	35.56	28.25	25.23	28.56	33.68	31.407
Ours: Hash (1 min)	35.92 ●	33.05 ●	34.34 ●	36.78	29.33	25.82 ●	30.20 ●	35.63 ●	32.635 ●
Ours: Hash (5 min)	36.22 ●	33.51 ●	35.00 ●	37.40 ●	29.78 ●	26.02 ●	31.10 ●	36.39 ●	33.176 ●
mip-NeRF (~hours)	36.51 ●	33.29 ●	35.14 ●	37.48 ●	30.71 ●	25.48 ●	30.41 ●	35.70 ●	33.090 ●
NSVF (~hours)	34.27	31.23	33.19	37.14 ●	32.68 ●	25.18	27.93	32.29	31.739
NeRF (~hours)	32.91	30.13	33.00	36.18	29.62	25.01	28.65	32.54	31.005
Ours: Frequency (5 min)	31.89	28.74	31.02	34.86	28.93	24.18	28.06	32.77	30.056
Ours: Frequency (1 min)	26.62	24.72	28.51	32.61	26.36	21.33	24.32	28.88	26.669

1. Background

3D Gaussian Splatting

- 3D Gaussian is optimized adaptively to represent geometry and color
- Tile-based Rasterization rendering makes faster than previous ray sampling of previous NeRF.



1. Background

3D Gaussian Splatting



InstantNGP (9.2 fps)
Train: 7min, PSNR: 22.1



Plenoxels (8.2 fps)
Train: 26min, PSNR: 21.9



Mip-NeRF360 (0.071 fps)
Train: 48h, PSNR: 24.3



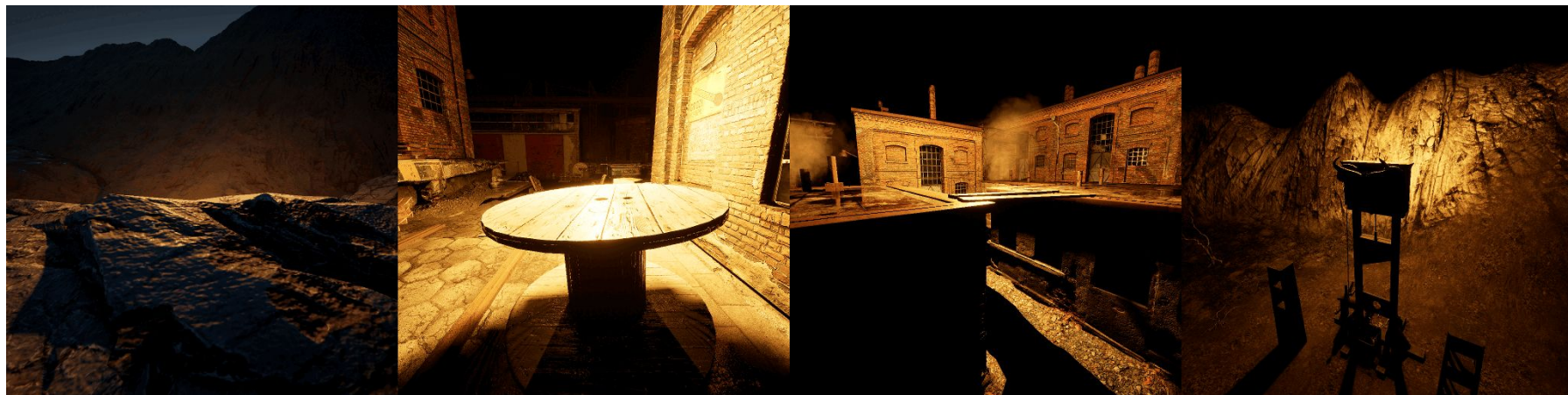
Ours (135 fps)
Train: 6min, PSNR: 23.6



Ours (93 fps)
Train: 51min, PSNR: 25.2

1. Background

Relighting



Varying color temperature

1. Background

Relighting



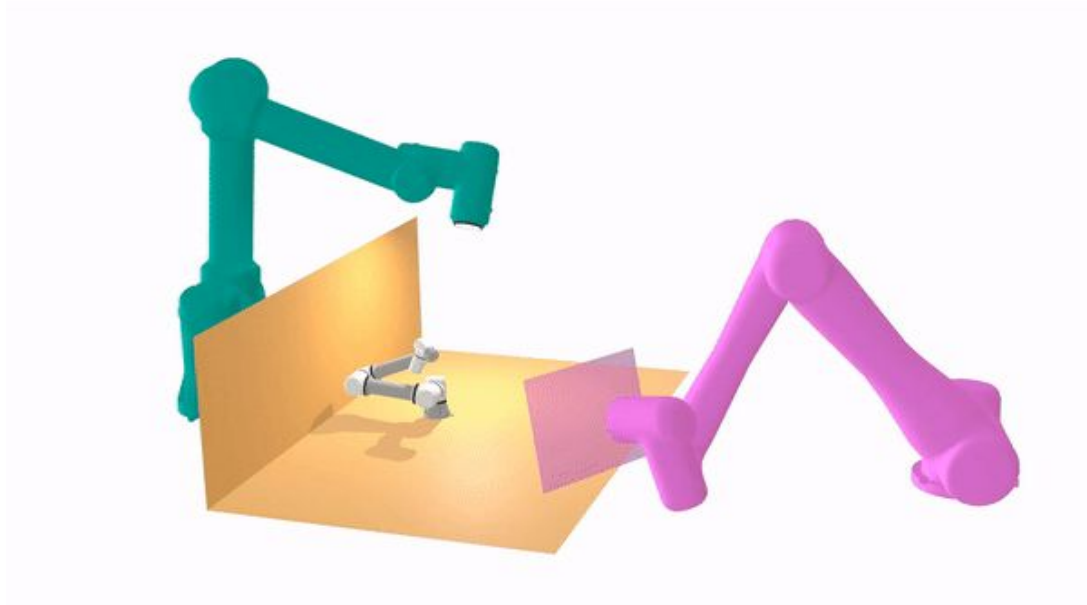
Varying direction

Motivation

Relightable View Synthesis

2. Motivation

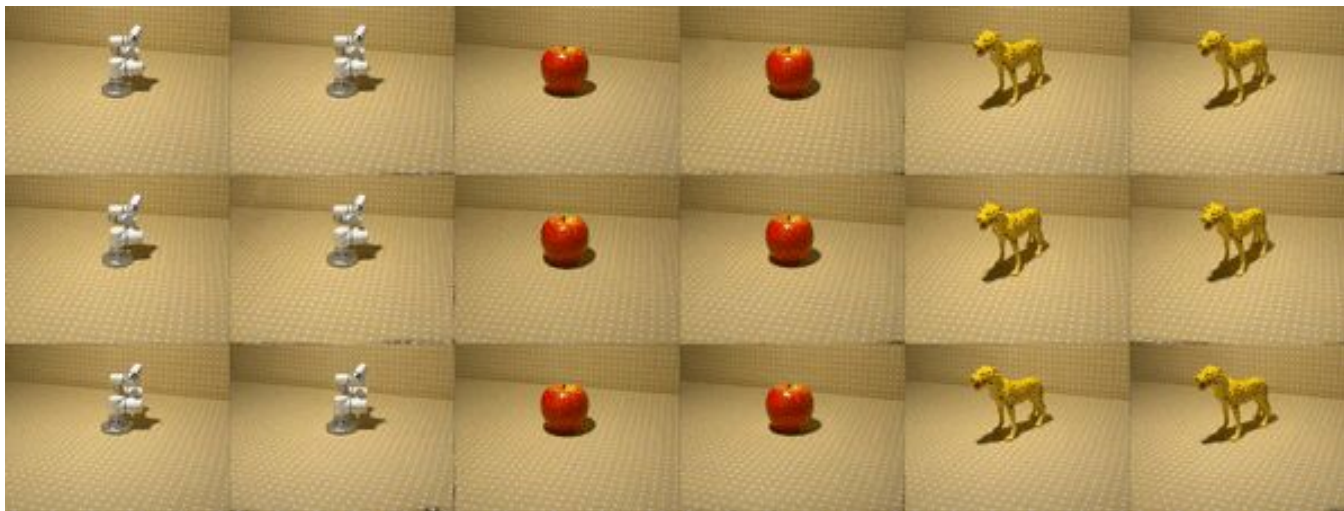
Relight My NeRF



2. Motivation

Relight My NeRF

Dataset with images in novel view and varying light direction.



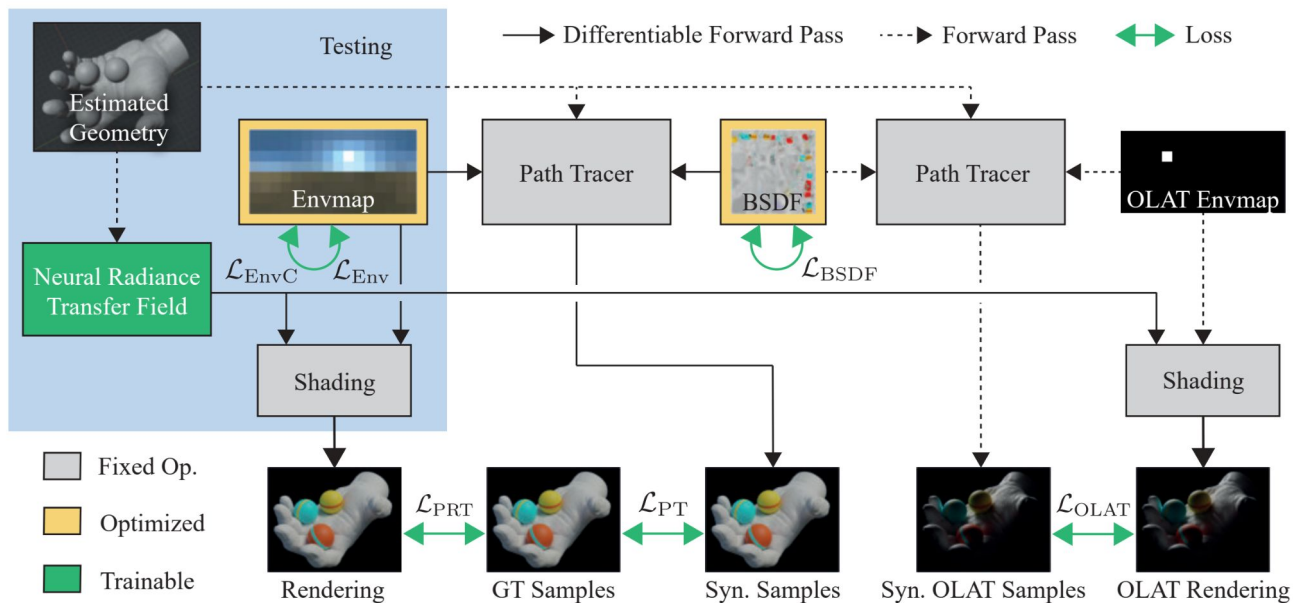
2. Motivation

Relight My NeRF




3. Related Work

NRTF (Neural Radiance Transfer Fields)

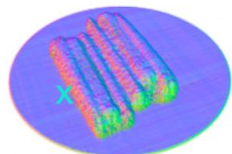


3. Related Work

NeRV (Neural Reflectance and Visibility Fields)


$$= \int_{\mathcal{S}} \left(\begin{array}{c} \text{(b) Light Visibility} \\ \times \\ \text{(c) Direct Illumination} \\ + \\ \text{(d) Indirect Illumination} \end{array} \right) \times \begin{array}{c} \text{(e) BRDF} \end{array} d\omega_i$$

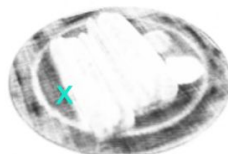
(a) Our Rendered Image
(Novel View and Lighting)



(f) Normals



(g) Albedo



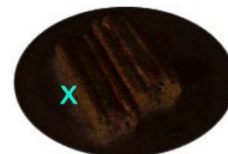
(h) Roughness



(i) Shadow Map



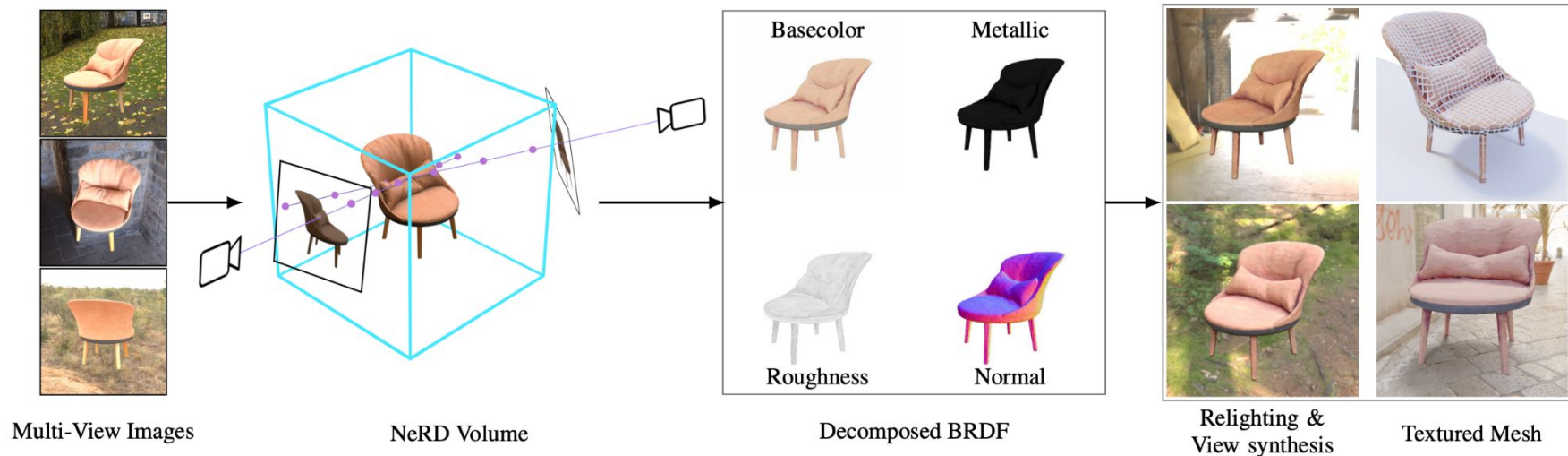
(j) Direct



(k) Indirect

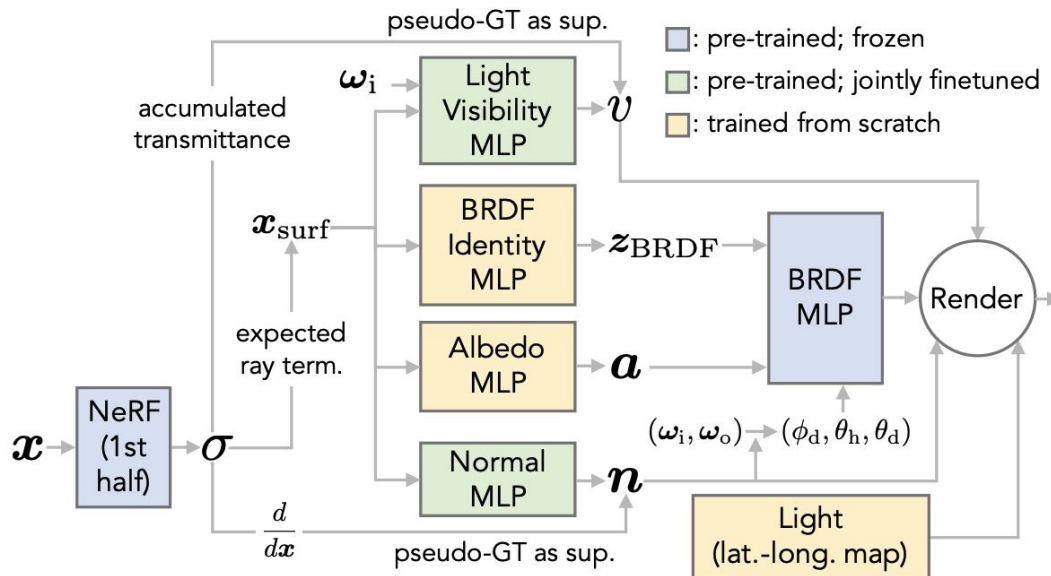
3. Related Work

NeRD (Neural Reflectance Decomposition)



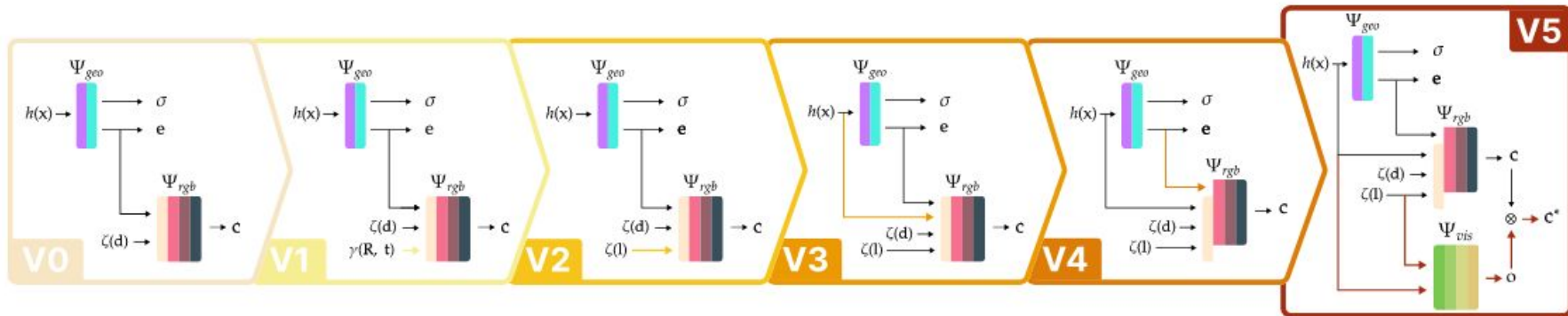
3. Related Work

NeRFactor (Neural Factorization)



3. Related Work

Relight My NeRF



3. Related Work

Current limitations

Methods		Training time	Computation resources
NeRV		1 day	128 TPU cores
NeRD		1.5 days	4 NVIDIA 2080 Ti
NeRFactor	NeRF	6-8 hours	4 NVIDIA TITAN RTX
	normals and visibility (per view)	30 min	1 NVIDIA TITAN RTX
	geometry	20 min	1 NVIDIA TITAN RTX
	joint optimization (per view)	30 min	1 NVIDIA TITAN RTX
Baseline of Relight My NeRF		5 hours	1 NVIDIA 2080 Ti

3. Related Work

Current limitations

The baseline only handles the varying direction,
not varying color temperature of the light

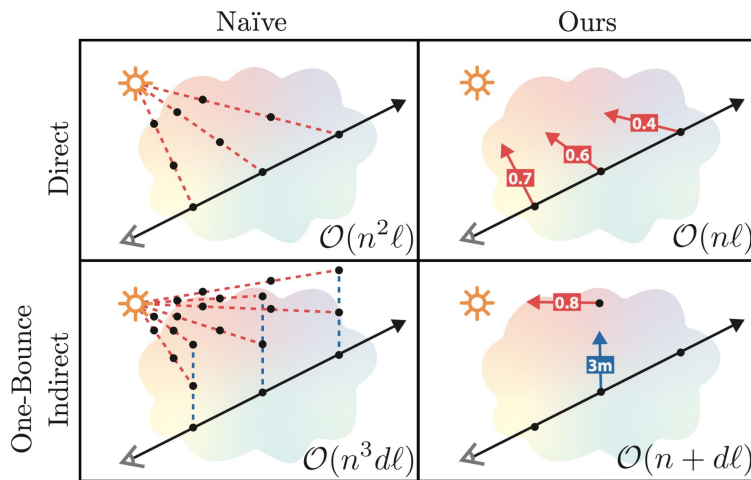
Approach

Relightable 3D Gaussian Splatting

4. Approach

Light Visibility

Whether the light ray reach to the query point



4. Approach

Light Visibility

Consider the light as camera, and render the scene

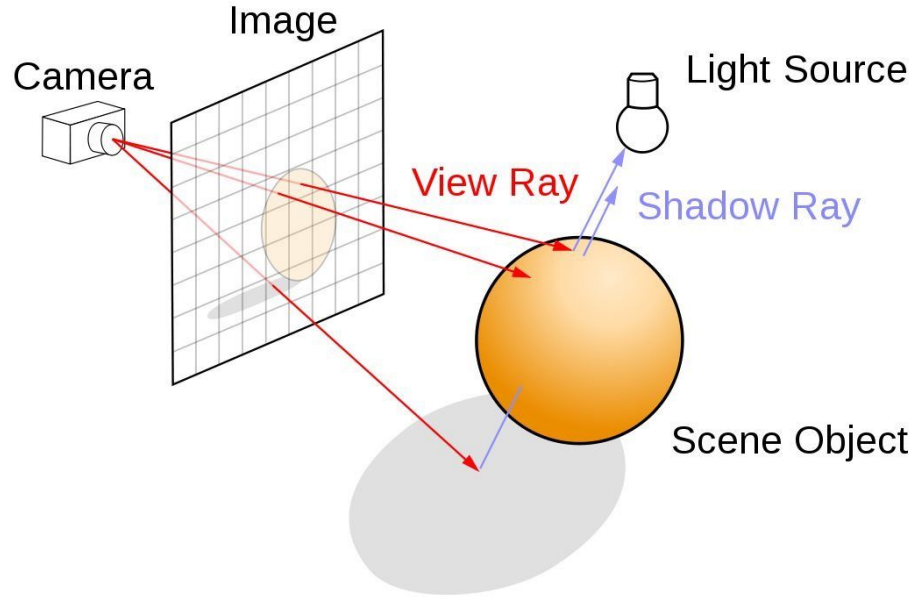
The visible 3D gaussian \rightarrow 1 for light visibility

The invisible 3D gaussian \rightarrow 0 for light visibility

We have to render twice, but the rendering speed of 3D Gaussian Splatting is **fast!**

4. Approach

Light Visibility



5. Role Division

Donghwan Kim: implement baseline of Relight My NeRF

Minje Kim: expand 3D Gaussian Splatting for relighting

References

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