3D Gaussian Splatting for Relightable View Synthesis

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Contents

1. Recap

Presented Paper

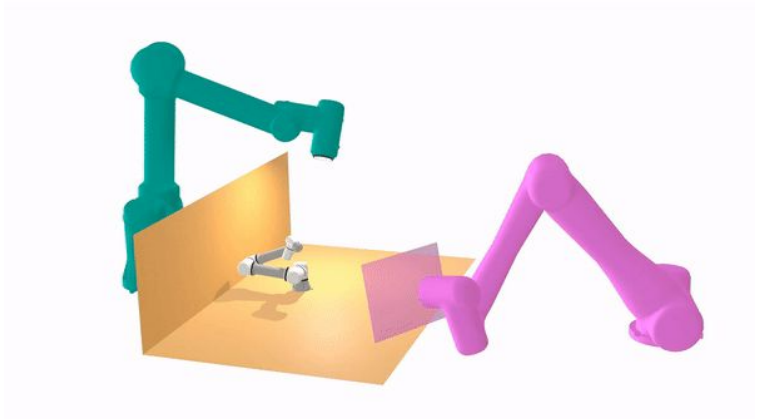
1. **NeRV**: Neural Reflectance and Visibility Fields for Relighting and View Synthesis (CVPR 2021)
2. **Relight My NeRF**: A Dataset for Novel View Synthesis and Relighting of Real World Objects (CVPR 2023)
3. **3D Gaussian Splatting** for Real-Time Radiance Field Rendering (SIGGRAPH 2023)

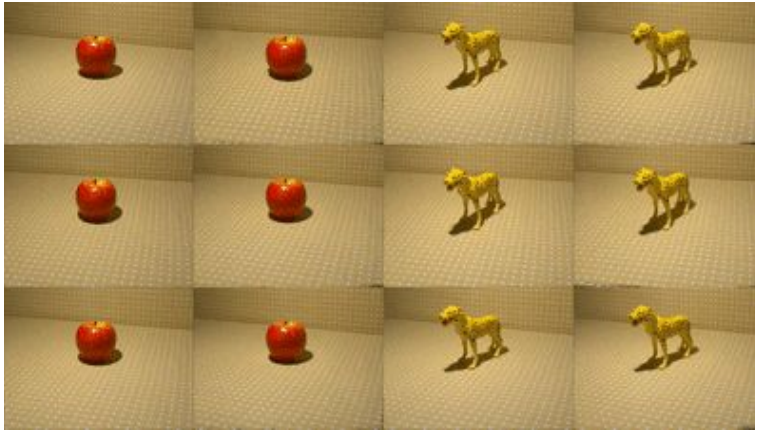
1. Recap

Relight My NeRF

Creating a dataset for relighting NeRF

1. Moving light
2. Moving camera pose





Present benchmark through naive baselines

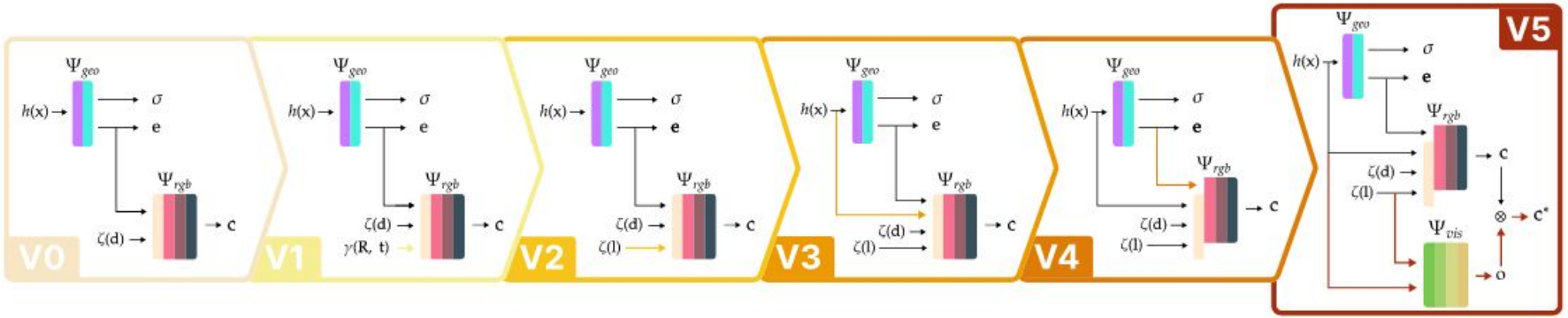
V1 ~ V5

Marco Toschi, Riccardo De Matteo, Riccardo Spezialetti, Daniele De Gregorio, Luigi Di Stefano, Samuele Salti. ReLight My NeRF: A Dataset for Novel View Synthesis and Relighting of Real World Objects. In *CVPR*, 2023. (Highlight)

1. Recap

Relight My NeRF

Relight My NeRF does not publish baseline codes, thus we implemented V1 ~ V5 baselines from torch-ngp.



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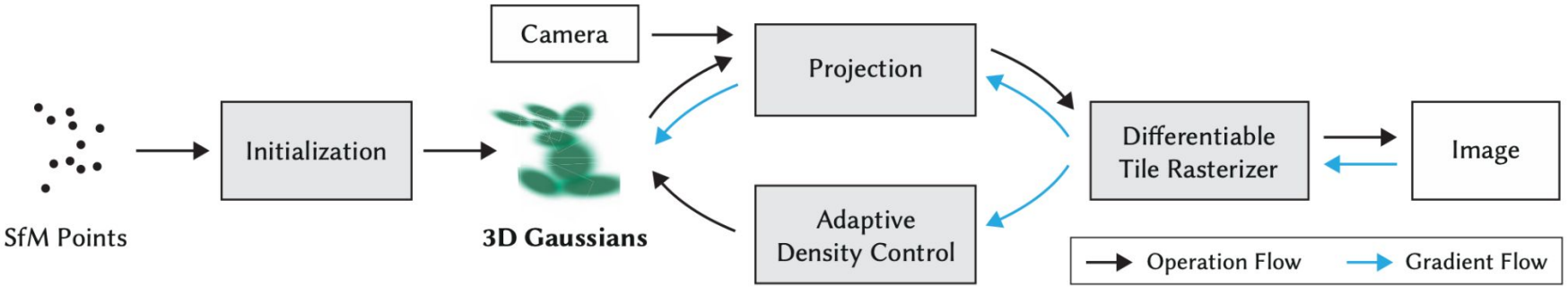
1. Recap

3D Gaussian Splatting

1. Starting from sparse point cloud
2. 3D gaussian optimization
3. Adaptive control of gaussians
4. Tile-based Rasterization

- State-of-the-art quality
- Real-time rendering
- Fast training



Bernhard Kerbl, Georgios Kopanas, Thomas Leimkühler, George Drettakis. 3D Gaussian Splatting for Real-Time Radiance Field Rendering. In *SIGGRAPH*, 2023.

Introduction

Relightable View Synthesis

2. Introduction

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

2. Introduction

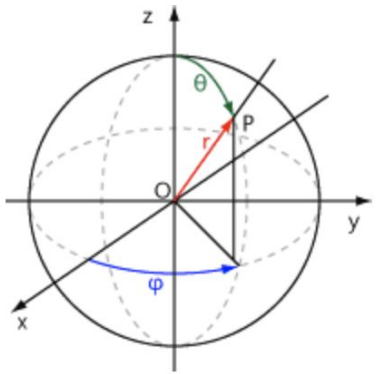
Relightable 3D Gaussian Splatting

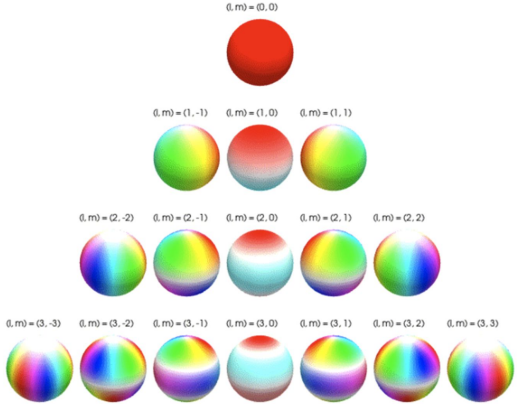
1. Even faster training time
2. Real-time rendering
3. Relighting ability

3. Method

Spherical Harmonics

- Color - Spherical Harmonics (SH) coefficients
- Differ by direction in spherical coordinate



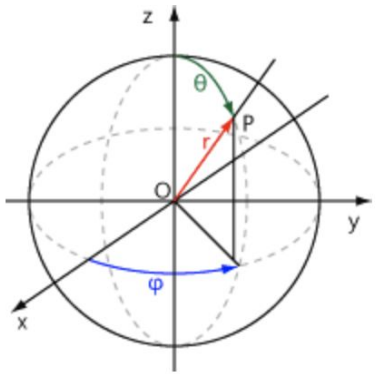


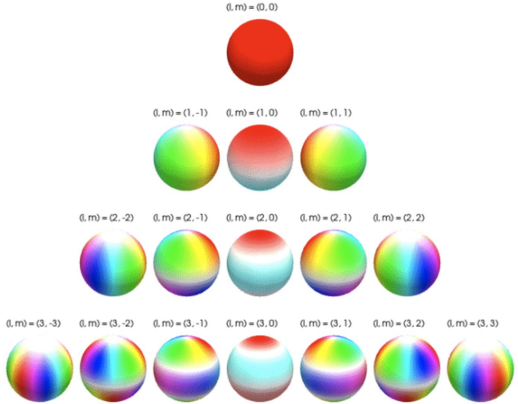
Robin Green. Spherical harmonic lighting: The gritty details. In Archives of the game developers conference, 2003.

3. Method

Relighting

- Original 3D Gaussian Splatting: camera-view-dependent color
- **Relighting 3D Gaussian Splatting (ours): light-direction-dependent color**





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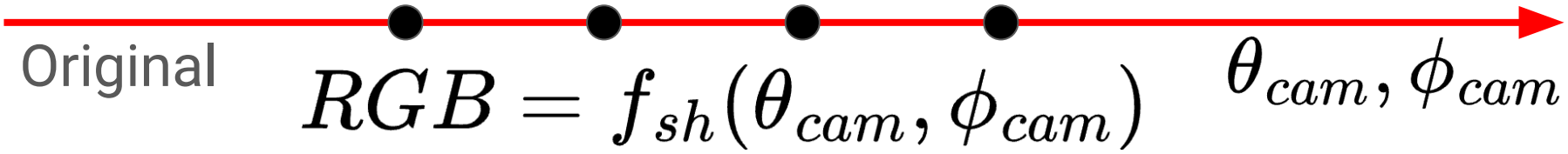
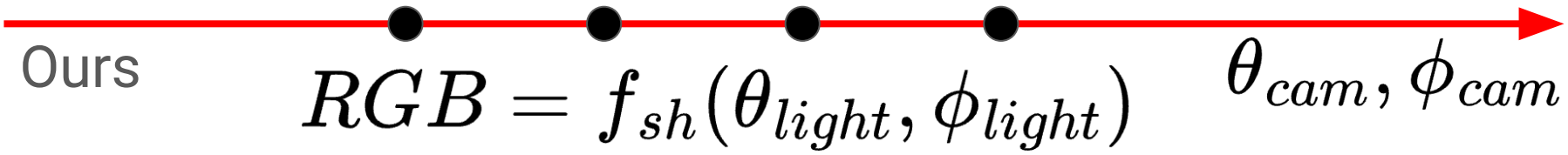
3. Method

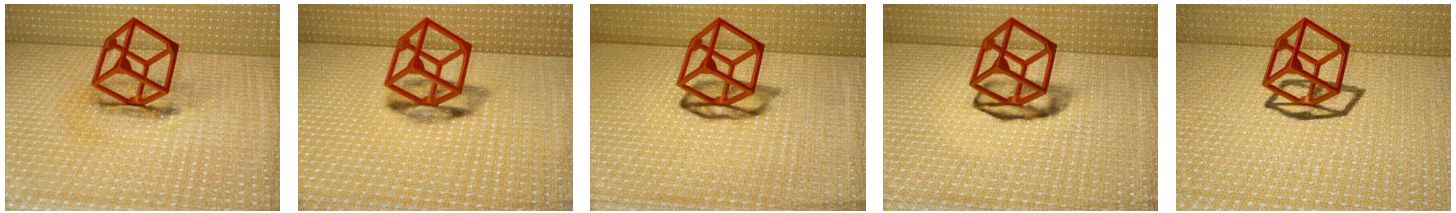
Relighting





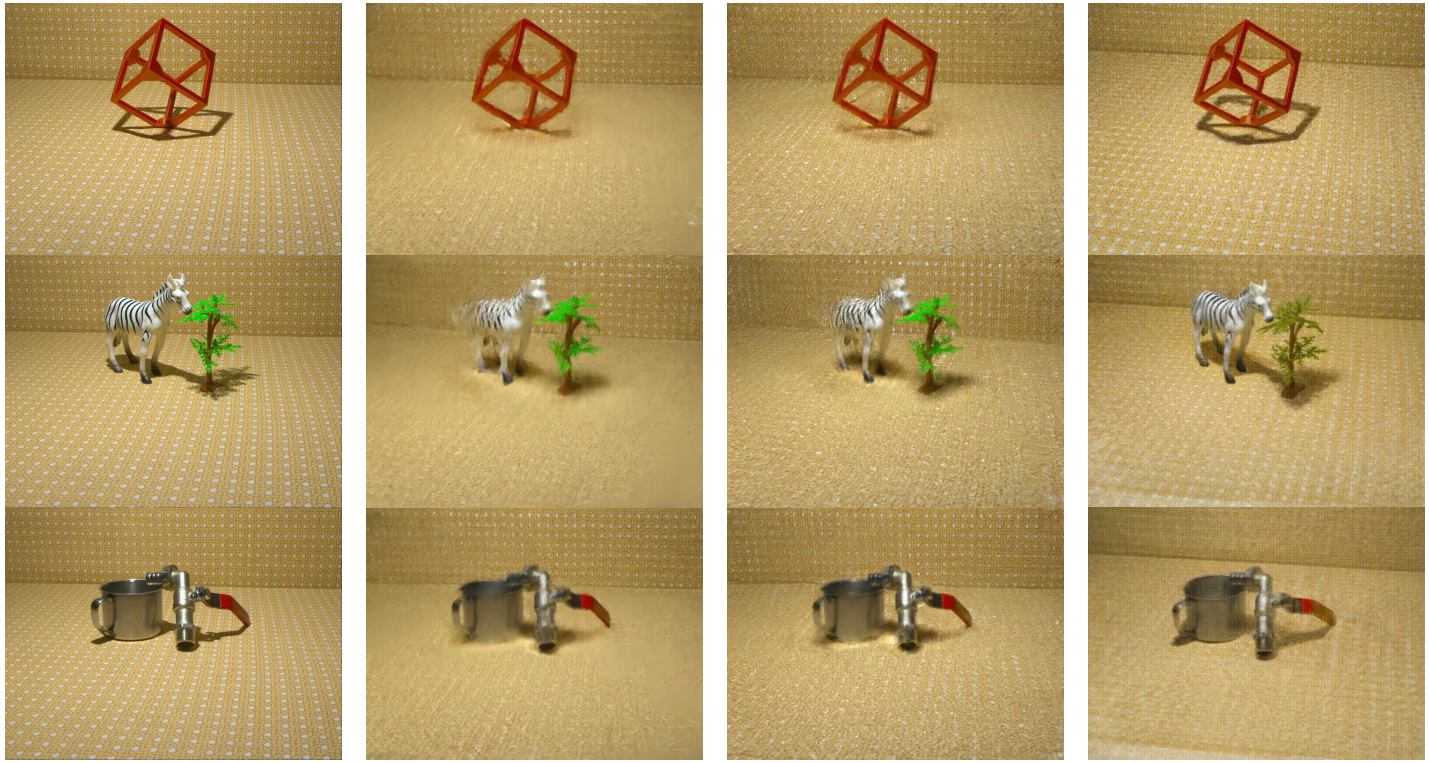
4. Results

Baseline Implementation



V1 V2 V3 V4 V5

4. Results



GT | Ours (10,000) | Ours (100,000) | ReNe (V5)

4. Results

Quantitative Evaluation

	Paper				Ours			
Scene	Cube		Savannah		Cube		Savannah	
Metric	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSRN	SSIM
V1	24.37	0.52	22.53	0.44	21.27	0.52	20.21	0.39
V2	24.73	0.54	23.70	0.52	22.24	0.53	20.30	0.40
V3	25.38	0.56	24.39	0.55	22.66	0.56	21.54	0.42
V4	25.41	0.57	24.79	0.58	22.28	0.57	21.59	0.41
V5	26.11	0.61	25.23	0.61	24.35	0.57	20.83	0.40

4. Results

Quantitative Evaluation

Model	Ours (10,000)			Ours (100,000)			ReNe (V5)		
Metric	PSNR	Training	FPS	PSNR	Training	FPS	PSNR	Training	FPS
Cube	21.34	1m 47s	357.27	21.66	34m 53s	265.30	24.34	5~7h	0.28
Savannah	19.94	1m 43s	343.60	19.8	35m 35s	217.00	20.83		
Reflective	21.28	1m 46s	355.03	21.84	35m 49s	257.37	22.04		

5. Conclusion

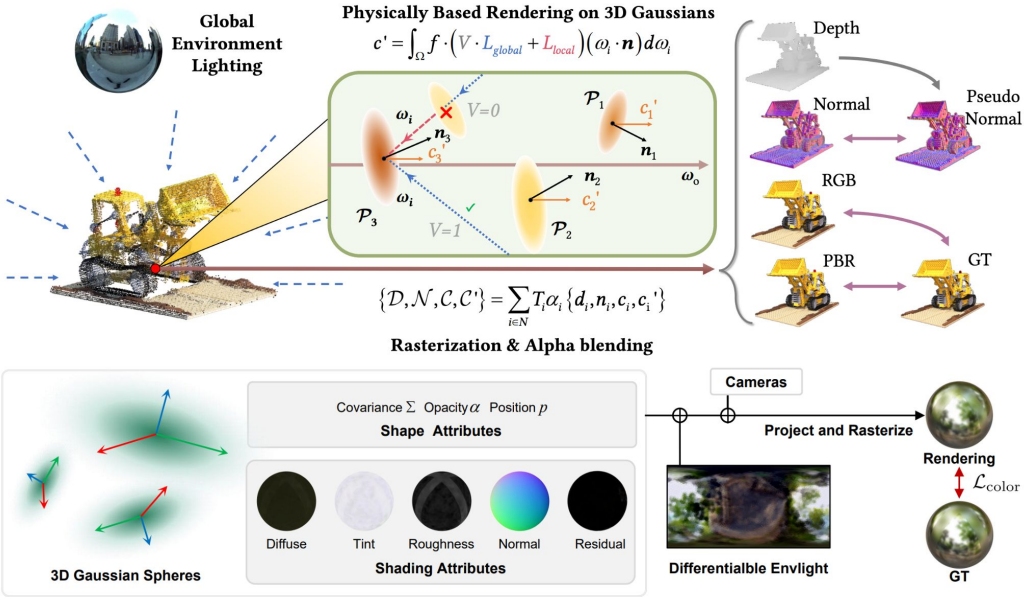
Limitation

1. Does not support 360 degrees view synthesis & varying light temperature/color
2. Does not support view-dependent color → restricted to diffuse condition
3. Need supervision on light direction

5. Conclusion

Limitation

Very recent works are published…



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Yingwenqi Jiang, Jiadong Tu, Yuan Liu, Xifeng Gao, Xiaoxiao Long, Wenping Wang, Yuexin Ma. GaussianShader: 3D Gaussian Splatting with Shading Functions for Reflective Surfaces. In Preprint, 2023. [Submitted on 29 Nov 2023]

5. Conclusion

Novelty, Practical Benefit, Lessons

Novelty

- very forefront problem settings

Practical Benefit

- relightable view synthesis with faster training and real-time rendering

Lessons

- CUDA code implementing
- project with hot and trendy work (3D Gaussian Splatting)

5. Role Division

Donghwan Kim: expand 3D Gaussian Splatting for relighting

Minje Kim: implement baselines of Relight My NeRF

References

Robin Green. Spherical harmonic lighting: The gritty details. In Archives of the game developers conference, 2003.

Ben Mildenhall, Pratul P. Srinivasan, Matthew Tancik, Jonathan T. Barron, Ravi Ramamoorthi, Ren Ng. NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis. In *ECCV*, 2020. (Oral)

Pratul P. Srinivasan, Boyang Deng, Xiuming Zhang, Matthew Tancik, Ben Mildenhall, Jonathan T. Barron. NeRV: Neural Reflectance and Visibility Fields for Relighting and View Synthesis. In *CVPR*, 2021.

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