GaussianShader: 3D Gaussian Splatting with Shading Functions for Reflective Surfaces

Supplementary Material

6. Residual Color Training Details

Residual color, comprising 3rd order SH coefficients, is initially excluded to ensure color learning is attributed to materials and lighting for accurate material separation, and introduced in the later training stages for refinement.

7. Additional Results

Relighting. In Fig. 11, we display objects reconstructed using our method, including relighting scenarios with different lighting conditions, featuring both warm and cool tones, and indoor and outdoor environments. Our renderings, spanning four diverse sets, convincingly show that the relit scenes maintain realism, with object highlights effectively mirroring the surrounding light sources, exemplifying our method's proficiency in relighting applications.

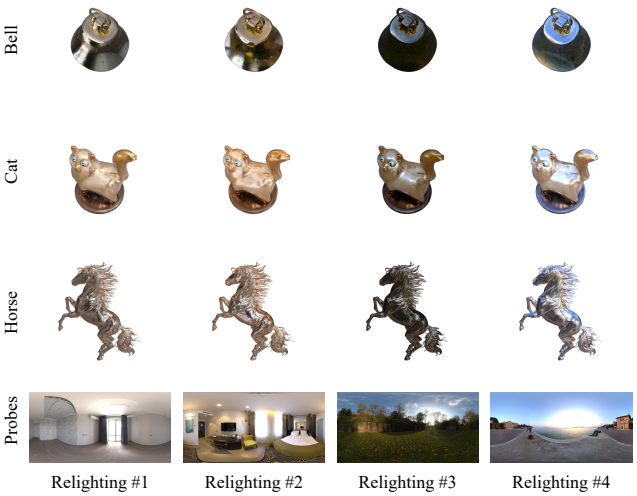

Figure 11. The image showcases a series of relighting results, where objects are from Glossy Synthetic [29] and rendered under four distinct lighting environments. Each column represents a different lighting condition, highlighting our method's ability to adaptively recast objects in diverse and dynamic light settings, from indoor ambient to outdoor natural light, thus validating the robustness and flexibility of our relighting technique.

Quantiative results on Glossy Synthetic [29]. Compared to Gaussian Splatting [21], our method registers a significant improvement on the Glossy Synthetic dataset [29], boasting an average PSNR increase of 1.1 as shown in Tab. 5. This superior performance stems from our detailed modeling of lighting and shading attributes, which facilitates a more accurate depiction of how light interacts with various surfaces. Precise normal orientation further refines this interaction, leading to renderings that faithfully reproduce the subtle reflections and refractions typical of glossy materials, thereby enhancing overall scene fidelity.

Quantiative results on Tanks and Temples [23]. In Tab. 6, our method shows a modest improvement on the Tanks and Temples dataset [23] comparing with Gaussian Splatting[21]. This is primarily because the objects within this dataset are predominantly diffuse, which does not fully leverage the strengths of our approach that are more pronounced in handling complex lighting scenarios.

Table 5. Quantitative comparisons with Guassian Splatting [21] on Glossy Synthetic [29]

	Glossy Synthetic [29]								
	Angel	Bell	Cat	Horse	Luyu	Potion	Tbell	Teapot	Avg.
	PSNR↑								
[21]	26.98	25.03	31.15	25.18	26.89	29.79	23.92	21.18	26.26
Ours	28.07	28.08	31.81	25.53	27.25	30.08	24.48	23.57	27.36
	SSIM↑								
[21]	0.915	0.901	0.959	0.910	0.916	0.934	0.901	0.875	0.914
Ours	0.923	0.920	0.961	0.918	0.915	0.936	0.897	0.899	0.921
	LPIPS↓								
[21]	0.070	0.107	0.060	0.067	0.064	0.090	0.119	0.102	0.085
Ours	0.065	0.097	0.056	0.062	0.064	0.087	0.121	0.090	0.080

Evaluation of normal estimation. We conduct the evaluation on the Shiny Blender dataset in Tab. 7. For GS [21], we use grad normals derived from the rendered depth map for evaluation. Except for the SDF based method ENVIDR [27], our method achieves the best results.

Visualization of the color decomposition. We provide a detailed decoupling for each component in Fig. 12. It is noteworthy that the residual is close to zero in most cases because the single-bounce reflection explains most of the reflection, while only regions with indirect reflections contain residual colors.

Visualization of lighting map. Additional visualizations of reconstructed environment lighting maps are presented in Fig. 13.

Table 6. Quantitative comparisons with Guassian Splatting [21] on Tanks and Temples [23].

	Tanks and Temples [23]					
	Barn	Caterpillar	Family	Ignatius	Truck	Avg.
	PSNR↑					
[21]	28.98	26.09	34.70	29.52	28.41	29.54
Ours	29.16	26.19	35.06	29.79	28.45	29.73
	SSIM↑					
[21]	0.921	0.932	0.981	0.973	0.945	0.951
Ours	0.923	0.931	0.982	0.973	0.944	0.951
	LPIPS↓					
[21]	0.110	0.075	0.024	0.032	0.059	0.060
Ours	0.104	0.074	0.023	0.032	0.056	0.058

Table 7. Comparison of normal MAE scores on Shiny Blender [45].

	Car	Ball	Helmet	Teapot	Toaster	Coffee	Avg.
Ref-NeRF [45]	14.93	1.55	29.48	9.23	42.84	12.24	18.38
ENVIDR [27]	7.10	0.74	1.66	2.47	6.45	9.23	**4.61**
GS [21]	44.11	31.37	48.24	30.75	48.52	24.99	38.00
Ours	22.91	2.59	14.57	10.58	14.02	10.90	<u>12.60</u>

Figure 12. Color decomposition.

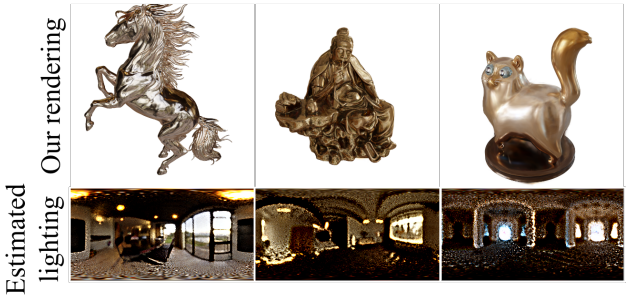

Figure 13. Reconstructed lighting maps.