Neural Shell Texture Splatting: More Details and Fewer Primitives

Supplementary Material

A. Implementation Details

Hash Encoding Parameters. We conducted experiments on the hash encoding parameters F, L, T using the NeRFSyn dataset in Table 1:

Table 1. Ablation study on hash grid parameters F, L, T.

$F=2, T=2^{19}$	$L=8$	$L=12$	$L=16$
PSNR↑	**33.09**	33.09	32.94
$F=4, T=2^{19}$	$L=4$	$L=6$	$L=8$
PSNR↑	33.30	**33.50**	33.28
$F=4, L=6$	$T=2^{18}$	$T=2^{19}$	$T=2^{20}$
PSNR↑	33.37	**33.50**	33.50

Considering the trade-offs between memory efficiency and reconstruction quality, we selected $F=4$ and $L=6$ as the main settings. For T, we used 2^{19} for object-level data and 2^{21} for scene-level data in our experiments.

Dataset Setting. The NeRFSyn dataset consists of 8 synthetic scenes at a resolution of 800×800. The DTU dataset includes 15 scenes, each with 49 or 64 images at a resolution of 1600×1200. Following 2DGS, we use Colmap sparse points and train at a reduced resolution of 800×600 for efficiency. We evaluate the DTU dataset using a fixed and consistent evaluation protocol, selecting images with indices $8, 13, 16, 21, 26, 31$, and 34. If the number of images exceeds 56, we additionally include the image with index 56. The MipNeRF360 dataset includes 5 outdoor and 4 indoor scenes. We train and test at half resolution for indoor scenes and quarter resolution for outdoor scenes, with test views sampled every 8 images.

Training Details The training process for GsTex involves two stages: we first train 2DGS from scratch for 15,000 iterations to obtain an initial set of Gaussians, followed by training GsTex for an additional 15,000 iterations. For SuperGS, we did not impose a restriction on the growth in the number of Gaussians, as we found that an inappropriate upper limit could lead to suboptimal results. All of our training was conducted on a single NVIDIA RTX 4090 GPU with 24GB of memory, which can accommodate a maximum of approximately 5.7 million Gaussians. Consequently, we encountered out-of-memory errors on the bicycle and treehill scenes from the MipNeRF360 dataset.

B. MipNeRF360 Results

Contraction Function As proposed in Mip-NeRF360, We map unbounded background into a bounded cubic region using the following contraction function:

$$\text{contract}(\mathbf{x}) = \begin{cases} \mathbf{x} & \|\mathbf{x}\| \leq 1 \\ (2 - \frac{1}{\|\mathbf{x}\|})(\frac{\mathbf{x}}{\|\mathbf{x}\|}) & \|\mathbf{x}\| > 1 \end{cases} \quad (1)$$

The coordinates of any ray-splat intersection is first normalized and then contracted before querying the hash grid features. The entire scene is contracted into a bounded $[-2, 2]$, with the foreground region normalized to the $[-1, 1]$.

	Outdoor Scene					Indoor Scene				
	PSNR↑	SSIM↑	LPIPS↓	Points↓	Size↓	PSNR↑	SSIM↑	LPIPS↓	Points↓	Size↓
3DGS	24.24	0.704	0.283	4821k	1140MB	31.03	0.921	0.188	1457k	344MB
2DGS	24.33	0.708	0.283	3360k	782MB	30.29	0.920	0.189	876k	204MB
SuperGS	OOM	OOM	OOM	OOM	OOM	30.23	0.917	0.188	1316k	463MB
GsTex	24.24	0.708	0.276	3067k	663MB	30.46	0.915	0.204	784k	221MB
Ours	23.85	0.690	0.257	1650k	257MB	30.59	0.911	0.174	356k	181MB

Table 2. **Quantitative results on MipNeRF360 indoor and outdoor scenes.** OOM indicates out-of-memory on a 24GB GPU. Our method achieves significant improvements in LPIPS scores while maintaining a smaller number of Gaussian primitives and a more compact model size.

Outdoor Scene We report all metrics for both indoor and outdoor scenes in Table 2. Our method produces more detailed rendering results and significantly improves the LPIPS metric, which aligns well with human visual perception. However, our method tends to overfit under-constrained background regions in outdoor scenes, resulting in lower PSNR and SSIM scores. We show qualitative comparisons in Figure 1, where our method achieves photo-realistic rendering results, particularly on flat, texture-rich regions such as the ground and grass without requiring the densification of a large number of Gaussian primitives.

C. More Results

We present detailed quantitative results of all methods on the NeRFSyn, DTU, and MipNeRF360 datasets in Table 3, Table 4, and Table 5, reporting PSNR, SSIM, and LPIPS metrics. We also invite readers to refer to our video results for better visualization.

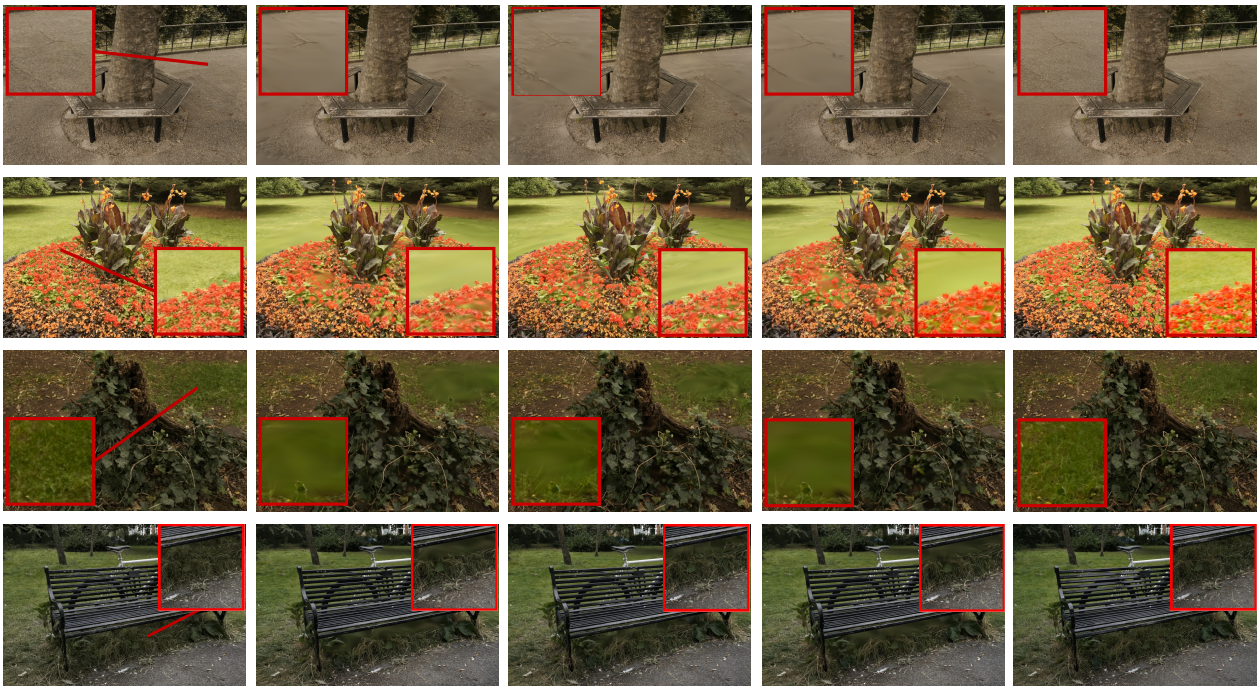

Figure 1. **Qualitative comparisons on the MipNeRF360-outdoor dataset.** Our method reveals finer details without densifying a large number of Gaussian primitives.

Method	Mic	Chair	Ship	Materials	Lego	Drums	Ficus	Hotdog	Mean
3DGS	35.42	35.90	30.90	30.00	35.78	26.16	34.85	37.70	33.34
2DGS	35.20	35.41	30.66	29.74	35.25	26.12	35.39	37.47	33.15
SuperGS	36.09	35.67	31.68	30.35	35.65	26.32	36.10	37.82	33.71
GsTex	34.78	35.23	30.78	30.29	35.82	26.12	35.96	37.93	33.37
Ours	36.30	35.23	31.27	29.70	35.27	26.16	36.23	37.80	33.50
3DGS	0.992	0.987	0.907	0.960	0.983	0.955	0.987	0.985	0.969
2DGS	0.991	0.987	0.903	0.958	0.981	0.954	0.988	0.985	0.968
SuperGS	0.992	0.988	0.909	0.959	0.981	0.955	0.988	0.985	0.970
GsTex	0.975	0.986	0.892	0.958	0.981	0.952	0.987	0.985	0.965
Ours	0.992	0.987	0.898	0.955	0.980	0.950	0.988	0.987	0.967
3DGS	0.006	0.010	0.106	0.036	0.016	0.036	0.011	0.019	0.030
2DGS	0.007	0.013	0.117	0.040	0.020	0.039	0.012	0.023	0.034
SuperGS	0.007	0.011	0.103	0.037	0.018	0.037	0.011	0.020	0.031
GsTex	0.018	0.015	0.138	0.048	0.022	0.047	0.014	0.027	0.041
Ours	0.007	0.012	0.097	0.044	0.018	0.047	0.012	0.019	0.032

Table 3. **Quantitative comparison of different methods on the NeRFSyn dataset.** We report PSNR↑, SSIM↑, and LPIPS↓ scores.

Method	24	35	40	55	63	65	69	83	97	105	106	110	114	118	122	Mean
3DGS	30.54	27.72	30.91	33.02	36.47	32.74	30.43	38.13	29.52	35.02	36.27	36.17	31.87	38.99	38.69	33.77
2DGS	30.68	27.78	31.26	33.28	35.67	33.21	30.59	37.85	29.54	34.78	36.48	35.86	32.32	39.57	39.50	33.89
SuperGS	30.00	27.92	31.20	33.63	35.69	32.72	30.88	37.38	29.94	34.39	36.77	36.25	32.55	39.98	39.73	33.94
GsTex	31.01	28.01	31.08	33.38	35.21	33.07	30.83	38.00	29.64	34.73	36.68	36.12	32.54	39.78	39.63	33.98
Ours	30.37	27.84	31.08	33.26	35.63	32.94	30.73	37.43	29.78	34.82	36.57	36.52	32.45	39.95	40.04	33.96
3DGS	0.946	0.933	0.933	0.975	0.974	0.972	0.950	0.983	0.953	0.969	0.973	0.976	0.960	0.981	0.983	0.965
2DGS	0.946	0.936	0.940	0.977	0.973	0.975	0.951	0.982	0.953	0.966	0.974	0.974	0.963	0.981	0.985	0.966
SuperGS	0.947	0.938	0.942	0.979	0.975	0.975	0.954	0.982	0.956	0.969	0.975	0.976	0.965	0.983	0.986	0.967
GsTex	0.946	0.936	0.934	0.978	0.972	0.972	0.950	0.983	0.953	0.967	0.973	0.975	0.963	0.980	0.985	0.964
Ours	0.944	0.940	0.937	0.976	0.972	0.974	0.952	0.982	0.954	0.966	0.975	0.977	0.962	0.982	0.985	0.965
3DGS	0.045	0.056	0.089	0.027	0.029	0.037	0.062	0.026	0.056	0.042	0.044	0.053	0.044	0.028	0.020	0.044
2DGS	0.053	0.055	0.086	0.025	0.031	0.039	0.066	0.030	0.062	0.053	0.046	0.060	0.051	0.033	0.022	0.048
SuperGS	0.043	0.053	0.080	0.024	0.028	0.037	0.060	0.029	0.057	0.044	0.041	0.050	0.045	0.029	0.019	0.043
GsTex	0.050	0.053	0.091	0.025	0.031	0.038	0.064	0.027	0.060	0.047	0.044	0.053	0.049	0.029	0.020	0.045
Ours	0.046	0.054	0.081	0.027	0.029	0.037	0.059	0.022	0.056	0.042	0.037	0.039	0.046	0.028	0.019	0.042

Table 4. **Quantitative comparison of different methods on the DTU dataset.** We report PSNR↑, SSIM↑, and LPIPS↓ scores.

	Outdoor Scene						Intdoor Scene				
Method	bicycle	flowers	garden	stump	treehill	Mean	room	counter	kitchen	bonsai	Mean
3DGS	24.71	21.09	26.63	26.45	22.33	24.24	31.50	28.96	31.38	32.26	31.03
2DGS	24.82	20.99	26.91	26.41	22.52	24.33	30.87	28.16	30.66	31.45	30.29
SuperGS	OOM	21.68	27.31	26.72	OOM	-	30.00	28.71	30.66	31.57	30.23
GsTex	24.68	21.17	26.76	26.24	22.33	24.24	31.15	28.50	30.72	31.48	30.46
Ours	24.49	20.05	26.68	25.87	22.20	23.85	31.30	28.45	30.61	32.02	30.59
3DGS	0.729	0.571	0.834	0.762	0.627	0.704	0.915	0.905	0.924	0.939	0.921
2DGS	0.731	0.573	0.845	0.764	0.630	0.708	0.915	0.905	0.924	0.939	0.920
SuperGS	OOM	0.616	0.867	0.779	OOM	-	0.908	0.905	0.922	0.931	0.917
GsTex	0.730	0.582	0.849	0.758	0.621	0.708	0.910	0.896	0.919	0.934	0.915
Ours	0.729	0.521	0.844	0.737	0.619	0.690	0.909	0.888	0.916	0.931	0.911
3DGS	0.265	0.377	0.147	0.266	0.362	0.283	0.219	0.201	0.127	0.205	0.188
2DGS	0.271	0.378	0.138	0.263	0.369	0.283	0.219	0.201	0.127	0.205	0.189
SuperGS	OOM	0.320	0.104	0.020	OOM	-	0.219	0.200	0.131	0.202	0.188
GsTex	0.265	0.365	0.138	0.248	0.365	0.276	0.237	0.221	0.141	0.218	0.204
Ours	0.236	0.358	0.129	0.246	0.317	0.257	0.194	0.202	0.125	0.176	0.174

Table 5. **Quantitative comparison of different methods on the MipNeRF360 dataset.** We report PSNR↑, SSIM↑, and LPIPS↓ scores for both indoor and outdoor scenes.