







# SPaGS: Fast and Accurate 3D Gaussian Splatting for Spherical Panoramas — Supplementary Material

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<https://junboli-cn.github.io/spags>

## 1. Hyperparameter Settings

Our hyperparameter settings largely follows HTGS [HFW\*25]. Because all splats are visible in every image due to the nature of the omnidirectional camera setup, we start densification early at 200 iterations instead of at iteration 500. Following 3DGS [KKLD23], we do not apply opacity decay and instead reset all opacities every 3000 iterations to a maximum of 0.1 during densification. Furthermore, we do not utilize visibility score-based pruning [NMR\*25] and instead subtract 0.001 from the opacity of every splat after each densification step. We empirically found this to provide a better balance between reconstruction of fine detail and maintaining a low splat count during densification. Lastly, we change the gradient threshold for densification to  $5e - 5$ .

## 2. Per-Scene Quality Metrics

We include per-scene quality metrics for all evaluated scenes in Tabs. 1 to 3.

## References

- [BMV\*23] BARRON J. T., MILDENHALL B., VERBIN D., SRINIVASAN P. P., HEDMAN P.: Zip-NeRF: Anti-aliased grid-based neural radiance fields. In *Int. Conf. Comput. Vis.* (2023), pp. 19640–19648. doi:10.1109/ICCV51070.2023.01804. 2, 3
- [CKK23] CHOI C., KIM S. M., KIM Y. M.: Balanced spherical grid for egocentric view synthesis. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (2023), pp. 16590–16599. doi:10.1109/CVPR52729.2023.01592. 2, 3
- [CXG\*22] CHEN A., XU Z., GEIGER A., YU J., SU H.: TensorRF: Tensorial radiance fields. In *Eur. Conf. Comput. Vis.* (2022), Springer-Verlag, pp. 333–350. doi:10.1007/978-3-031-19824-3\_20. 2, 3
- [HFW\*25] HAHLBOHM F., FRIEDERICH S., WEYRICH T., FRANKE L., KAPPEL M., CASTILLO S., STAMMINGER M., EISEMANN M., MAGNOR M.: Efficient perspective-correct 3D gaussian splatting using hybrid transparency. *Computer Graphics Forum (Proc. of Eurographics EG)* (Apr 2025), e70014 ff. doi:10.1111/cgf.70014. 1
- [KKLD23] KERBL B., KOPANAS G., LEIMKUEHLER T., DRETTAKIS G.: 3D Gaussian splatting for real-time radiance field rendering. *ACM Trans. Graph.* 42, 4 (2023). doi:10.1145/3592433. 1

- [LCHL24] LEE S., CHUNG J., HUH J., LEE K. M.: Odgs: 3d scene reconstruction from omnidirectional images with 3d gaussian splattings. In *Neural Information Processing Systems* (2024). 2, 3
- [LHYC24] LI L., HUANG H., YEUNG S.-K., CHENG H.: OmniGS: Omnidirectional Gaussian Splatting for Fast Radiance Field Reconstruction using Omnidirectional Images. *arXiv preprint arXiv:2404.03202* (2024). 2, 3
- [MESK22] MÜLLER T., EVANS A., SCHIED C., KELLER A.: Instant neural graphics primitives with a multiresolution hash encoding. *ACM Trans. Graph.* 41, 4 (2022). doi:10.1145/3528223.3530127. 2, 3
- [NMR\*25] NIEMEYER M., MANHARDT F., RAKOTOSAONA M.-J., OECHSLE M., DUCKWORTH D., GOSULA R., TATENO K., BATES J., KAESER D., TOMBARI F.: RadSplat: Radiance field-informed Gaussian splatting for robust real-time rendering with 900+ fps. In *International Conference on 3D Vision* (2025). 1
- [TWN\*23] TANCİK M., WEBER E., NG E., LI R., YI B., KERR J., WANG T., KRISTOFFERSEN A., AUSTIN J., SALAHİ K., AHUJA A., MCALLISTER D., KANAZAWA A.: Nerfstudio: A modular framework for neural radiance field development. In *SIGGRAPH Asia Conference Papers* (2023), Association for Computing Machinery. doi:10.1145/3588432.3591516. 2, 3

SSIM $\uparrow$ on Ricoh360 [CKK23]												
Method	bricks	bridge	bridge_under	cat_tower	center	farm	flower	gallery_chair	gallery_pillar	garden	poster	Average
Instant-NGP $\dagger$ [MESK22]	0.707	0.709	0.765	0.662	0.850	0.585	0.613	0.840	0.810	0.702	0.820	0.733
TensorRF $\dagger$ [CXG*22]	0.718	0.714	0.743	0.670	0.850	0.589	0.625	0.849	0.815	0.698	0.830	0.737
Zip-NeRF $\dagger$ [BMV*23]	0.770	0.760	0.835	0.670	0.882	0.591	0.683	0.880	0.832	0.724	0.847	0.770
EgoNeRF [CKK23]	0.748	0.734	0.794	0.697	0.858	0.661	0.632	0.847	0.845	0.725	0.853	0.763
ODGS [LCHL24]	0.727	0.739	0.739	0.693	0.789	0.626	0.624	0.817	0.791	0.742	0.811	0.736
OmniGS [LHYC24]	0.843	0.793	0.877	0.775	0.894	0.731	0.729	0.895	0.887	0.797	0.902	0.829
Ours	0.847	0.810	0.880	0.782	0.902	0.748	0.736	0.894	0.894	0.804	0.897	0.836
PSNR $\uparrow$ on Ricoh360 [CKK23]												
Method	bricks	bridge	bridge_under	cat_tower	center	farm	flower	gallery_chair	gallery_pillar	garden	poster	Average
Instant-NGP $\dagger$ [MESK22]	22.28	22.65	23.92	23.25	27.65	20.66	21.19	26.19	25.93	25.76	24.40	23.99
TensorRF $\dagger$ [CXG*22]	23.00	23.24	24.14	23.61	28.72	20.96	21.94	27.98	26.90	26.10	25.29	24.72
Zip-NeRF $\dagger$ [BMV*23]	23.23	23.68	25.66	23.29	29.64	20.53	22.38	28.86	26.90	26.28	25.48	25.08
EgoNeRF [CKK23]	23.33	23.44	24.98	24.25	28.49	22.19	21.81	27.80	28.00	26.86	26.61	25.25
ODGS [LCHL24]	22.35	22.91	23.03	22.09	24.12	19.81	20.14	25.37	24.28	23.86	24.08	22.91
OmniGS [LHYC24]	24.73	23.72	26.60	24.82	29.44	22.28	22.39	28.93	28.72	27.06	28.44	26.10
Ours	24.45	23.98	26.57	25.10	29.75	22.48	22.64	28.46	29.12	27.61	27.65	26.17
LPIPS $\downarrow$ on Ricoh360 [CKK23]												
Method	bricks	bridge	bridge_under	cat_tower	center	farm	flower	gallery_chair	gallery_pillar	garden	poster	Average
Instant-NGP $\dagger$ [MESK22]	0.353	0.362	0.325	0.390	0.263	0.372	0.421	0.334	0.314	0.348	0.329	0.346
TensorRF $\dagger$ [CXG*22]	0.358	0.355	0.367	0.373	0.297	0.391	0.421	0.361	0.323	0.373	0.320	0.358
Zip-NeRF $\dagger$ [BMV*23]	0.249	0.269	0.215	0.296	0.195	0.315	0.316	0.252	0.246	0.279	0.254	0.262
EgoNeRF [CKK23]	0.326	0.349	0.311	0.366	0.288	0.372	0.401	0.339	0.321	0.346	0.325	0.340
ODGS [LCHL24]	0.382	0.369	0.407	0.386	0.461	0.456	0.452	0.429	0.428	0.376	0.399	0.413
OmniGS [LHYC24]	0.240	0.282	0.197	0.268	0.232	0.297	0.302	0.257	0.284	0.289	0.247	0.263
Ours	0.216	0.242	0.182	0.248	0.194	0.266	0.280	0.238	0.254	0.265	0.233	0.238

**Table 1:** Per-scene image quality metrics for the Ricoh360 [CKK23] dataset. The three best results are highlighted in green in descending order of saturation. For methods marked with  $\dagger$  we used the implementation provided by Nerfstudio [TWN\*23].

SSIM $\uparrow$ on OmniBlender [CKK23]												
Method	archviz-flat	barbershop	classroom	restroom	bistro_bike	bistro_square	fisher-hut	lone_monk	lou	pavilion_midday_chair	pavilion_midday_pond	Average
Instant-NGP $\dagger$ [MESK22]	0.851	0.874	0.796	0.656	0.717	0.519	0.756	0.675	0.871	0.834	0.631	0.744
TensorRF $\dagger$ [CXG*22]	0.885	0.941	0.819	0.829	0.871	0.812	0.789	0.886	0.909	0.875	0.719	0.849
Zip-NeRF $\dagger$ [BMV*23]	0.916	0.964	0.875	0.851	0.913	0.647	0.784	0.786	0.949	0.962	0.806	0.859
EgoNeRF [CKK23]	0.932	0.961	0.844	0.873	0.962	0.909	0.810	0.940	0.915	0.939	0.829	0.901
ODGS [LCHL24]	0.945	0.953	0.830	0.843	0.943	0.906	0.824	0.941	0.909	0.898	0.783	0.888
OmniGS [LHYC24]	0.962	0.964	0.866	0.902	0.980	0.958	0.873	0.971	0.960	0.944	0.831	0.928
Ours	0.964	0.953	0.867	0.899	0.980	0.959	0.882	0.970	0.970	0.945	0.818	0.928
PSNR $\uparrow$ on OmniBlender [CKK23]												
Method	archviz-flat	barbershop	classroom	restroom	bistro_bike	bistro_square	fisher-hut	lone_monk	lou	pavilion_midday_chair	pavilion_midday_pond	Average
Instant-NGP $\dagger$ [MESK22]	29.33	27.86	26.31	26.18	24.67	17.10	28.14	22.82	29.25	26.86	22.32	25.53
TensorRF $\dagger$ [CXG*22]	31.88	33.52	30.92	32.09	29.14	24.29	30.03	28.72	31.99	29.43	24.45	29.68
Zip-NeRF $\dagger$ [BMV*23]	33.30	35.95	33.61	33.42	29.92	19.82	29.87	25.40	36.37	33.29	26.15	30.64
EgoNeRF [CKK23]	33.43	35.09	30.40	33.70	34.11	25.94	30.47	31.60	33.99	31.55	26.09	31.49
ODGS [LCHL24]	33.08	34.47	27.87	32.87	31.51	25.36	30.69	30.71	30.40	28.58	24.35	29.99
OmniGS [LHYC24]	35.79	35.25	31.91	36.00	37.63	29.14	32.39	35.17	37.04	31.01	25.65	33.36
Ours	36.06	33.30	31.95	35.57	37.53	29.39	33.12	35.12	37.26	31.50	25.35	33.29
LPIPS $\downarrow$ on OmniBlender [CKK23]												
Method	archviz-flat	barbershop	classroom	restroom	bistro_bike	bistro_square	fisher-hut	lone_monk	lou	pavilion_midday_chair	pavilion_midday_pond	Average
Instant-NGP $\dagger$ [MESK22]	0.346	0.385	0.425	0.482	0.460	0.604	0.395	0.470	0.259	0.331	0.474	0.421
TensorRF $\dagger$ [CXG*22]	0.236	0.214	0.413	0.331	0.255	0.325	0.354	0.234	0.217	0.252	0.378	0.292
Zip-NeRF $\dagger$ [BMV*23]	0.184	0.162	0.228	0.250	0.227	0.479	0.347	0.297	0.121	0.079	0.264	0.240
EgoNeRF [CKK23]	0.168	0.146	0.324	0.262	0.091	0.167	0.291	0.162	0.152	0.140	0.208	0.192
ODGS [LCHL24]	0.153	0.198	0.403	0.362	0.160	0.212	0.266	0.130	0.222	0.237	0.288	0.239
OmniGS [LHYC24]	0.108	0.135	0.344	0.267	0.091	0.132	0.203	0.078	0.125	0.115	0.229	0.166
Ours	0.098	0.131	0.293	0.252	0.079	0.118	0.187	0.078	0.111	0.106	0.236	0.153

**Table 2:** Per-scene image quality metrics for the OmniBlender [CKK23] dataset, separated into indoor and outdoor scenes. The three best results are highlighted in green in descending order of saturation. For methods marked with  $\dagger$  we used the implementation provided by Nerfstudio [TWN\*23].

SSIM $\uparrow$ on Roaming & Rounding											
Method	<i>alley</i>	<i>avenue</i>	<i>bridge</i>	<i>bypath</i>	<i>garden</i>	<i>car</i>	<i>lion</i>	<i>statuary</i>	<i>stone</i>	<i>windmill</i>	Average
Instant-NGP $\dagger$ [MESK22]	0.705	0.614	0.533	0.789	0.539	0.604	0.731	0.665	0.593	0.628	0.640
TensoRF $\dagger$ [CXG*22]	0.701	0.717	0.610	0.823	0.573	0.501	0.747	0.682	0.610	0.606	0.657
Zip-NeRF $\dagger$ [BMV*23]	0.777	0.684	0.614	0.842	0.567	0.681	0.823	0.723	0.685	0.727	0.712
EgoNeRF [CKK23]	0.722	0.710	0.610	0.820	0.583	0.720	0.752	0.698	0.661	0.652	0.693
ODGS [LCHL24]	0.765	0.766	0.647	0.846	0.607	0.809	0.822	0.749	0.748	0.726	0.749
OmniGS [LHYC24]	0.840	0.883	0.739	0.914	0.756	0.889	0.901	0.826	0.845	0.828	0.842
Ours	0.842	0.875	0.740	0.915	0.750	0.882	0.885	0.819	0.835	0.799	0.834

PSNR $\uparrow$ on Roaming & Rounding											
Method	<i>alley</i>	<i>avenue</i>	<i>bridge</i>	<i>bypath</i>	<i>garden</i>	<i>car</i>	<i>lion</i>	<i>statuary</i>	<i>stone</i>	<i>windmill</i>	Average
Instant-NGP $\dagger$ [MESK22]	22.89	19.79	19.62	25.35	20.13	20.91	24.72	22.24	21.94	23.66	22.13
TensoRF $\dagger$ [CXG*22]	21.49	24.78	21.72	27.22	22.31	9.21	26.06	22.63	20.89	16.98	21.33
Zip-NeRF $\dagger$ [BMV*23]	24.76	23.53	21.65	27.82	21.60	22.55	27.64	23.56	23.40	25.56	24.21
EgoNeRF [CKK23]	23.54	24.69	21.61	26.76	22.82	23.07	25.83	23.07	22.97	24.25	23.86
ODGS [LCHL24]	23.52	23.81	20.64	25.54	21.24	23.40	25.40	22.02	22.60	23.05	23.12
OmniGS [LHYC24]	26.33	29.12	23.21	30.70	25.42	26.75	29.20	25.29	25.47	27.10	26.86
Ours	26.20	28.64	23.48	30.53	25.38	26.48	28.68	25.24	25.25	26.55	26.64

LPIPS $\downarrow$ on Roaming & Rounding											
Method	<i>alley</i>	<i>avenue</i>	<i>bridge</i>	<i>bypath</i>	<i>garden</i>	<i>car</i>	<i>lion</i>	<i>statuary</i>	<i>stone</i>	<i>windmill</i>	Average
Instant-NGP $\dagger$ [MESK22]	0.434	0.561	0.559	0.402	0.565	0.456	0.379	0.452	0.419	0.438	0.466
TensoRF $\dagger$ [CXG*22]	0.474	0.447	0.495	0.385	0.538	0.651	0.390	0.456	0.457	0.552	0.484
Zip-NeRF $\dagger$ [BMV*23]	0.342	0.467	0.451	0.338	0.511	0.389	0.259	0.377	0.355	0.343	0.383
EgoNeRF [CKK23]	0.417	0.448	0.488	0.374	0.510	0.334	0.357	0.414	0.355	0.417	0.411
ODGS [LCHL24]	0.369	0.385	0.434	0.349	0.483	0.286	0.301	0.365	0.318	0.365	0.365
OmniGS [LHYC24]	0.261	0.210	0.337	0.233	0.301	0.183	0.169	0.270	0.209	0.264	0.244
Ours	0.249	0.217	0.329	0.226	0.295	0.178	0.180	0.263	0.208	0.273	0.242

**Table 3:** Per-scene image quality metrics for our Roaming & Rounding dataset, separated into roaming and rounding scenes. The three best results are highlighted in green in descending order of saturation. For methods marked with  $\dagger$  we used the implementation provided by Nerfstudio [TWN\*23].