--Supplementary Material-- Representing Boundary-ambiguous Scene Online with Scale-encoded Cascaded Grids and Radiance Field Deblurring

Shenghao Li, Zeyang Xia, *Senior Member, IEEE*, Qunfei Zhao

This supplementary material provides additional experimental results of the online scene representation benchmark and the ablation study. The quantitative results in the online scene representation benchmark considering the medians for five consecutive runs are reported.

A. Impact on Different Color losses

In Table X, we provide the experimental results on the impact of different color losses, including ℓ_1 loss, ℓ_2 loss, and Charbonnier loss. Although ℓ_1 loss delivers higher SSIM and LPIPS scores, the Charbonnier loss achieves a more balanced and stable performance considering both the photometric and geometric performances. Therefore, the Charbonnier loss is chosen as the color loss in the proposed online scene representation method.

B. Additional Results of Evaluation On Replica

In Table XI, we provide detailed results for all Replica scenes. All the experiments on Replica are executed at the original resolution on all 8 sequences.

C. Additional Results of Evaluation On TUM

In Table XII, we provide detailed results for the selected TUM scenes under hand-held shooting conditions. 10 sequences from TUM are considered in the evaluation on TUM, including the test sequences adopted in [4].

D. Additional Results of Evaluation On KITTI

In Table XIII, we provide the detailed results for the selected KITTI scenes under urban conditions. The ground-truth camera trajectory lengths are listed beside the selected sequences.

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Shenghao Li is with the Department of Automation, School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University, Shanghai 200240, China. (email: lch94102@sjtu.edu.cn)

Zeyang Xia is with the Soft Robotics Research Center, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, China, and also with the CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen Institute of Advanced Technology, Shenzhen 518055, China. (email: zy.xia@siat.ac.cn)

Qunfei Zhao is with the Ningbo Artificial Intelligence Institute and the Department of Automation, Shanghai Jiao Tong University, Shanghai 200240, China. (email: zhaoqf@sjtu.edu.cn)

TABLE X
THE IMPACT OF DIFFERENT COLOR LOSSES

Method	Average			
	PSNR↑	SSIM↑	LPIPS↓	D.ℓ_1 [cm]↓
ℓ_1	**22.71**	**0.778**	**0.283**	7.266
ℓ_2	22.69	0.743	0.333	**6.780**
Charb.	**22.83**	**0.774**	**0.288**	**7.175**

* The experiments are executed on the fr1/desk, fr1/plant and fr1/teddy sequences of TUM. The best and second best methods are marked as **red** and **blue**.

E. Additional Results of Evaluation on SelfCap

In Table XIV, we provide the detailed results for our custom dataset, SelfCap, under indoor and outdoor scenes with unknown camera pose, boundary ambiguity, and observation noise. We captured two indoor and two outdoor scenes at different scales following the settings in Unbounded360 [6]. Since the ground-truth camera motion trajectories are not available due to the equipment limitation, we focus on the photometric metrics as reported in Table XIV.

F. Additional Results of Verification on Online Scene Representation

In Table XV, we provide the detailed verification results on online scene representation. The verification is conducted on the selected TUM scenes, as in Table XII.

G. Additional Results of Verification on Implicit Function

In Table XVI and Table XVII, we provide the detailed results of the verification on the proposed implicit scene representation function $\mathcal{S}$ on Unbounded360 [6] and TaTs [38], respectively.

TABLE XI
FULL EVALUATION RESULTS ON REPLICA

Seq.	iMAP* [5]			NICE-SLAM [4]			Ours.S			Ours.L		
	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓
office0	28.92	2.211	4.186	29.33	1.031	1.088	35.81	2.580	0.659	39.64	0.633	0.659
office1	29.99	1.372	4.672	30.85	0.719	0.899	38.57	0.974	0.618	39.64	0.633	0.618
office2	23.52	2.606	4.940	24.79	13.990	1.613	28.59	5.074	1.331	32.07	6.351	1.331
office3	28.19	8.100	6.501	24.50	2.267	2.573	26.18	10.694	0.990	32.14	7.680	0.990
office4	25.90	4.404	2.724	25.45	2.312	8.531	29.55	9.981	6.934	32.74	3.687	6.681
room0	26.77	2.078	4.755	23.53	2.240	1.691	26.88	11.014	0.659	30.55	1.470	0.659
room1	24.16	2.391	4.802	24.43	2.212	12.087	30.87	4.649	0.509	33.92	0.583	0.509
room2	23.75	5.673	7.312	25.74	1.991	2.054	30.89	5.077	1.464	33.59	1.051	1.464
Average	26.40	3.604	4.987	26.08	**3.345**	3.817	**30.92**	6.255	**1.646**	**34.29**	**2.761**	**1.409**

* The best and second best methods are marked as **red** and **blue**.

TABLE XII
FULL EVALUATION RESULTS ON TUM

Seq.	iMAP* [5]			NICE-SLAM [4]			Ours.S			Ours.L		
	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓	PSNR↑	D.ℓ_1 [cm]↓	ATE [cm]↓
fr1/desk	13.06	10.086	6.830	14.06	8.151	2.845	23.45	4.114	1.750	24.56	3.344	1.598
fr1/plant	13.58	32.536	7.051	14.67	9.942	8.556	20.99	10.722	1.805	22.37	8.479	1.136
fr1/teddy	13.99	24.839	10.513	14.93	10.143	9.229	20.64	10.710	4.409	21.57	9.700	4.274
fr2/rpy	22.62	3.280	1.714	16.96	16.708	2.275	24.34	4.782	0.589	24.43	3.812	0.305
fr2/xyz	19.49	5.899	2.135	20.24	4.219	2.526	26.09	3.543	0.866	27.25	2.378	0.346
fr3/cabinet	18.59	24.918	5.947	13.85	10.184	9.945	24.24	22.998	4.933	26.32	16.931	4.745
fr3/far	18.60	16.767	1.851	20.07	11.360	2.628	27.94	5.886	1.228	31.51	4.339	1.151
fr3/near	19.82	8.554	7.049	20.39	8.875	3.059	28.80	4.249	1.494	30.42	3.409	1.292
fr3/office	17.44	17.053	8.969	18.02	16.502	3.578	24.91	15.713	1.458	26.53	11.631	1.044
fr3/teddy	14.75	89.158	18.351	15.29	56.140	11.031	23.57	16.284	2.139	24.61	13.308	1.691
Average	17.19	23.309	7.041	16.85	15.222	5.567	**24.50**	**9.900**	**2.067**	**25.96**	**7.733**	**1.758**

* The best and second best methods are marked as **red** and **blue**.

TABLE XIII
FULL EVALUATION RESULTS ON KITTI

Seq. (Len.)	iMAP* [5]					NICE-SLAM [4]					Ours.L				
	PSNR↑	SSIM↑	D.ℓ_1 [m]↓	ATE [m]↓	Cov.↑	PSNR↑	SSIM↑	D.ℓ_1 [m]↓	ATE [m]↓	Cov.↑	PSNR↑	SSIM↑	D.ℓ_1 [m]↓	ATE [m]↓	Cov.↑
00 (714m)	11.71	0.417	7.87	47.13	54%	9.95	0.343	11.53	27.80	12%	17.67	0.590	6.115	1.92	100%
02 (585m)	11.75	0.348	5.53	5.99	32%	9.09	0.333	8.84	23.85	30%	18.80	0.552	3.11	0.57	100%
05 (719m)	11.43	0.346	7.98	84.44	65%	11.39	0.425	15.53	197.34	4%	17.28	0.528	5.14	2.85	100%
06 (883m)	12.52	0.349	15.77	41.74	13%	9.97	0.311	25.18	53.66	11%	18.42	0.540	12.57	1.71	100%
09 (521m)	10.89	0.328	11.78	20.15	39%	8.57	0.311	0.169	16.86	12%	19.29	0.553	8.14	5.55	100%
Average	**11.66**	**0.358**	**9.79**	**39.89**	**40%**	9.79	0.344	15.59	66.12	14%	**18.29**	**0.553**	**7.02**	**2.52**	**100%**

* The best and second best methods are marked as **red** and **blue**. The trajectory lengths in meters are presented beside the sequence names.

TABLE XIV
FULL EVALUATION RESULTS ON SELFCAP

	Seq.	iMAP* [5]			NICE-SLAM [4]			Ours. w/o Deblur			Ours.DN.			Ours.L		
		PSNR↑	SSIM↓	LPIPS↓	PSNR↑	SSIM↓	LPIPS↓	PSNR↑	SSIM↓	LPIPS↓	PSNR↑	SSIM↓	LPIPS↓	PSNR↑	SSIM↓	LPIPS↓
Observation	indoor1	19.26	0.670	0.512	19.54	0.692	0.468	23.85	0.775	0.353	23.98	0.754	0.367	30.08	0.872	0.270
	indoor2	22.77	0.835	0.338	22.17	0.792	0.397	25.73	0.865	0.258	35.72	0.952	0.133	33.72	0.938	0.155
	outdoor1	9.38	0.338	0.708	13.99	0.403	0.582	20.38	0.576	0.493	25.24	0.727	0.372	25.60	0.736	0.370
	outdoor2	18.37	0.488	0.621	21.75	0.663	0.591	27.69	0.767	0.498	27.18	0.728	0.499	31.37	0.820	0.379
	Average	17.44	0.583	0.544	19.36	0.637	0.509	24.41	0.746	0.400	**28.03**	**0.790**	**0.343**	**30.19**	**0.841**	**0.294**
Ground Truth	indoor1	18.22	0.519	0.575	18.49	0.541	0.524	24.15	0.651	0.411	22.45	0.638	0.357	26.80	0.716	0.315
	indoor2	20.53	0.708	0.443	20.20	0.680	0.456	23.00	0.773	0.342	26.06	0.838	0.211	27.99	0.849	0.218
	outdoor1	9.01	0.258	0.723	13.14	0.312	0.608	20.38	0.576	0.493	19.44	0.570	0.411	22.34	0.695	0.357
	outdoor2	17.41	0.376	0.651	19.86	0.508	0.641	22.53	0.586	0.576	23.02	0.576	0.571	26.03	0.667	0.398
	Average	16.29	0.465	0.598	17.92	0.510	0.557	22.51	0.646	0.456	**22.74**	**0.656**	**0.387**	**25.79**	**0.732**	**0.322**

* The best and second best methods are marked as **red** and **blue**.

TABLE XV
FULL COMPARISON OF ONLINE AND OFFLINE SCENE REPRESENTATIONS ON TUM

Sequence	Ours.Online				Ours.Offline			
	PSNR↑	SSIM↑	LPIPS↓	D.ℓ_1 [m]↓	PSNR↑	SSIM↑	LPIPS↓	D.ℓ_1 [m]↓
fr1/desk	24.56	0.848	0.222	3.344	23.50	0.819	0.274	3.579
fr1/plant	22.37	0.753	0.299	8.479	21.74	0.746	0.309	8.825
fr1/teddy	21.57	0.723	0.343	9.700	21.11	0.719	0.345	10.030
fr2/rpy	24.43	0.824	0.216	3.812	23.48	0.822	0.233	3.991
fr2/xyz	27.25	0.879	0.155	2.378	26.21	0.861	0.196	2.679
fr3/cab	26.32	0.853	0.305	16.931	25.37	0.838	0.325	17.264
fr3/far	31.51	0.931	0.070	4.339	30.93	0.925	0.079	4.441
fr3/near	30.42	0.906	0.126	3.409	29.77	0.899	0.137	3.495
fr3/office	26.53	0.850	0.209	11.631	25.96	0.840	0.227	11.850
fr3/teddy	24.61	0.804	0.323	13.308	23.93	0.789	0.336	13.686
Average	**25.96**	**0.837**	**0.227**	**7.733**	25.20	0.836	0.246	7.984

* The best method is marked as **red**.

TABLE XVI
ADDITIONAL RESULTS OF SCENE REPRESENTATION VERIFICATION RESULTS ON UNBOUNDED360

	Method	Bicycle	Gardens	Stump	Room	Counter	Kitchen	Bonsai	Average
PSNR	NeRF [3]†	21.76	23.11	21.73	28.56	25.67	26.31	26.81	24.85
	Mip-NeRF [19]†	21.69	23.16	23.10	28.73	25.59	26.47	27.13	25.12
	NeRF++ [27]†	22.64	24.32	24.34	28.87	26.38	27.80	29.15	26.21
	Mip-NeRF.L [19]†	22.90	25.85	23.64	30.67	28.61	29.95	31.59	27.60
	NeRF++.L [27]†	23.75	25.91	25.48	30.13	27.79	29.85	30.68	27.66
	MipNeRF360 [6]†	24.37	26.98	26.40	31.63	29.55	32.23	33.46	29.23
	Our Func.	21.51	27.61	24.22	34.12	29.56	33.99	34.29	**29.33**
	Our Func.L	21.12	27.89	24.78	34.63	29.75	34.19	34.96	**29.62**
SSIM	NeRF [3]†	0.455	0.546	0.453	0.843	0.775	0.749	0.792	0.659
	Mip-NeRF [19]†	0.454	0.543	0.517	0.851	0.779	0.745	0.818	0.672
	NeRF++ [27]†	0.526	0.635	0.594	0.852	0.802	0.816	0.876	0.729
	Mip-NeRF.L [19]†	0.612	0.777	0.643	0.903	0.877	0.902	0.928	0.806
	NeRF++.L [27]†	0.630	0.761	0.687	0.883	0.857	0.888	0.913	0.803
	MipNeRF360 [6]†	0.685	0.813	0.744	0.913	0.894	0.920	0.941	0.844
	Our Func.	0.585	0.844	0.713	0.954	0.918	0.960	0.968	**0.849**
	Our Func.L	0.571	0.854	0.732	0.959	0.923	0.961	0.971	**0.853**
LPIPS	NeRF [3]†	0.536	0.415	0.551	0.353	0.394	0.335	0.398	0.426
	Mip-NeRF [19]†	0.541	0.422	0.490	0.346	0.390	0.336	0.370	0.414
	NeRF++ [27]†	0.455	0.331	0.416	0.335	0.351	0.260	0.291	0.348
	Mip-NeRF.L [19]†	0.372	0.205	0.357	0.229	0.239	0.152	0.204	0.251
	NeRF++.L [27]†	0.356	0.223	0.328	0.270	0.270	0.177	0.230	0.265
	MipNeRF360 [6]†	0.301	0.170	0.261	0.211	0.204	0.127	0.176	0.207
	Our Func.	0.326	0.127	0.264	0.078	0.109	0.049	0.044	**0.142**
	Our Func.L	0.321	0.118	0.246	0.072	0.102	0.049	0.040	**0.136**

* The best and second best methods are marked as **red** and **blue**. † marks the results from [6].

TABLE XVII
ADDITIONAL RESULTS OF SCENE REPRESENTATION VERIFICATION RESULTS ON TATS

	Method	M60	Playground	Train	Truck	Average
PSNR	NeRF [3]†	17.59	21.72	19.17	20.21	19.67
	Mip-NeRF [19]†	17.58	22.21	19.42	20.50	19.93
	NeRF++ [27]†	18.09	23.05	19.50	21.44	20.52
	Mip-NeRF.L [19]†	19.14	23.65	19.82	21.74	21.09
	NeRF++.L [27]†	18.81	24.01	19.84	21.94	21.15
	MipNeRF360 [6]†	19.28	26.41	18.23	24.01	21.98
	Our Func.	21.65	26.39	20.63	24.79	**23.37**
	Our Func.L	21.69	26.37	21.00	24.93	**23.50**
SSIM	NeRF [3]†	0.619	0.624	0.575	0.646	0.616
	Mip-NeRF [19]†	0.629	0.638	0.582	0.650	0.625
	NeRF++ [27]†	0.644	0.676	0.586	0.704	0.653
	Mip-NeRF.L [19]†	0.694	0.726	0.642	0.747	0.702
	NeRF++.L [27]†	0.682	0.724	0.630	0.751	0.697
	MipNeRF360 [6]†	0.714	0.781	0.635	0.818	0.737
	Our Func.	0.775	0.792	0.706	0.840	**0.778**
	Our Func.L	0.778	0.815	0.714	0.845	**0.788**
LPIPS	NeRF [3]†	0.466	0.473	0.493	0.458	0.473
	Mip-NeRF [19]†	0.462	0.461	0.483	0.449	0.464
	NeRF++ [27]†	0.432	0.418	0.473	0.387	0.428
	Mip-NeRF.L [19]†	0.367	0.330	0.379	0.296	0.343
	NeRF++.L [27]†	0.383	0.348	0.409	0.308	0.362
	MipNeRF360 [6]†	0.341	0.264	0.389	0.223	0.304
	Our Func.	0.263	0.250	0.325	0.187	**0.256**
	Our Func.L	0.258	0.214	0.316	0.178	**0.242**

* The best and second best methods are marked as **red** and **blue**. † marks the results from [6].