

Supplementary Material for Rethinking the Upsampling Process in Light Field Super-Resolution with Spatial-Epipolar Implicit Image Function

In addition to the peak signal-to-noise ratio (PSNR) value listed in Table 1 and Table 3 of main paper, here we also present structural similarity (SSIM) and learned perceptual image patch similarity (LPIPS) value for a comprehensive comparison, in which LPIPS is calculated by using AlexNet as deep network activation to measure perceptual similarity. For PSNR and SSIM, larger numerical value means the predicted result is closer to ground truth, that is, the evaluated method has better performance. For LPIPS, smaller numerical value signifies better performance. Considering the characteristic of SSIM and LPIPS metric, all relevant scores are multiplied by 100 to amplify the gap.

A. Fixed-scale LFSSR

Similar to the PSNR variation trend in main paper, as shown in Tab. 1 and Tab. 2, all methods obtain better SSIM and LPIPS scores on almost every dataset by using the proposed SEIIF to replace original upsampling model in decoder part. Specifically, for more challenging $\times 4$ fixed-scale task, the improvements in SSIM and LPIPS brought by using our SEIIF are particularly significant. For easier $\times 2$ fixed-scale task, it is convenient for original upsampling model to achieve robust performance through fixed-scale training, thus partial methods with SEIIF undergo a slight SSIM or LPIPS degradation on EPFL and INRIA dataset, but the average scores on all five datasets are still improved. These observations comprehensively demonstrate the powerful decoding capability of the proposed SEIIF.

B. Arbitrary-scale LFSSR

Tab. 3 shows SSIM and LPIPS scores of arbitrary-scale LFSSR. Similar to PSNR results in main paper, the proposed SEIIF nearly gets best scores on both in-distribution scales and out-of-distribution scales under the identical encoder compared with

Table 1. Quantitative comparison of state-of-the-art LFSSR methods using original upsampling module (baseline) and using SEIIF for $2\times$ and $4\times$ SR on benchmark datasets. SSIM value improvement/drop brought by SEIIF is in red/blue in lower right corner. Baseline methods train different models for different scales. SEIIF-based methods use one model for all scales but has unique parameters for a specific scale.

Method	EPFL		HCInew		HCIdold		INRIA		STFgantry		Average	
	$\times 2$	$\times 4$	$\times 2$	$\times 4$	$\times 2$	$\times 4$	$\times 2$	$\times 4$	$\times 2$	$\times 4$	$\times 2$	$\times 4$
LF-InterNet	97.60	91.62	97.63	91.61	99.46	97.16	98.43	94.91	99.09	94.09	98.44	93.87
LF-InterNet + SEIIF	97.69 0.09	92.09 0.47	97.78 0.15	92.26 0.65	99.48 0.02	97.38 0.22	98.49 0.06	95.23 0.32	99.27 0.18	95.09 1.00	98.54 0.10	94.41 0.54
LF-DFnet	97.62	91.72	97.82	92.01	99.45	97.20	98.47	95.10	99.35	95.06	98.54	94.22
LF-DFnet + SEIIF	97.71 0.09	92.15 0.43	97.87 0.05	92.39 0.38	99.50 0.05	97.39 0.19	98.52 0.05	95.35 0.25	99.40 0.05	95.40 0.34	98.60 0.06	94.54 0.32
LF-IINet	97.73	91.88	97.90	92.08	99.48	97.34	98.53	95.15	99.36	95.02	98.60	94.29
LF-IINet + SEIIF	97.75 0.02	92.21 0.33	97.94 0.04	92.40 0.32	99.49 0.01	97.46 0.12	98.54 0.01	95.35 0.20	99.41 0.05	95.34 0.32	98.63 0.03	94.55 0.26
LFT	97.81	92.10	97.91	92.18	99.45	97.35	98.55	95.24	99.41	95.48	98.63	94.47
LFT + SEIIF	97.77 0.04	92.25 0.15	97.92 0.01	92.40 0.22	99.49 0.04	97.43 0.08	98.52 0.03	95.33 0.09	99.45 0.04	95.69 0.21	98.63 0.00	94.62 0.15
DistgSSR	97.87	91.95	97.96	92.17	99.49	97.32	98.59	95.19	99.42	95.34	98.67	94.39
DistgSSR + SEIIF	97.81 0.06	92.42 0.47	97.98 0.02	92.55 0.38	99.51 0.02	97.50 0.18	98.56 0.03	95.46 0.27	99.48 0.06	95.70 0.36	98.67 0.00	94.72 0.33
HLFSR	98.00	92.22	98.07	92.38	99.50	97.40	98.67	95.34	99.47	95.37	98.74	94.55
HLFSR + SEIIF	97.93 0.07	92.70 0.48	98.13 0.06	92.80 0.42	99.52 0.02	97.53 0.13	98.62 0.05	95.63 0.29	99.53 0.06	95.92 0.55	98.75 0.01	94.92 0.37
EPIT	97.75	91.97	98.10	92.31	99.49	97.37	98.53	95.26	99.57	95.71	98.69	94.52
EPIT + SEIIF	97.77 0.02	92.26 0.29	98.15 0.05	92.59 0.28	99.52 0.03	97.52 0.15	98.53 0.00	95.44 0.18	99.62 0.05	96.05 0.34	98.72 0.03	94.77 0.25
LF-DET	97.97	92.30	98.07	92.35	99.50	97.44	98.64	95.34	99.55	95.73	98.74	94.63
LF-DET + SEIIF	97.96 0.01	92.75 0.45	98.11 0.04	92.74 0.39	99.52 0.02	97.54 0.10	98.63 0.01	95.61 0.27	99.58 0.03	96.11 0.38	98.76 0.02	94.95 0.32

Results of all baselines are available in the famous LFSSR benchmark BasicLFSSR: <https://github.com/ZhengyuLiang24/BasicLFSSR>.

Table 2. Quantitative comparison of state-of-the-art LFSSR methods using original upsampling module (baseline) and using SEIIF for 2× and 4× SR on benchmark datasets. LPIPS value drop/improvement brought by SEIIF is in red/blue in lower right corner. Baseline methods train different models for different scales. SEIIF-based methods use one model for all scales but has unique parameters for a specific scale.

Method	EPFL		HCnew		HCold		INRIA		STFGantry		Average	
	×2	×4	×2	×4	×2	×4	×2	×4	×2	×4	×2	×4
LF-InterNet	3.97	21.84	3.94	24.85	1.44	12.45	4.33	21.43	1.59	13.23	3.05	18.76
LF-InterNet + SEIIF	3.58 0.39	19.57 2.27	3.49 0.45	22.44 2.41	1.31 0.13	10.77 1.68	4.15 0.18	19.17 2.26	1.25 0.34	10.28 2.95	2.76 0.29	16.45 2.31
LF-DFnet	3.70	20.60	3.31	23.17	1.49	11.97	4.28	19.41	0.92	10.27	2.74	17.08
LF-DFnet + SEIIF	3.61 0.09	19.58 1.02	3.25 0.06	22.03 1.14	1.38 0.11	11.24 0.73	3.99 0.29	18.74 0.67	0.82 0.10	9.30 0.97	2.61 0.13	16.18 0.90
LF-IINet	3.44	20.34	2.86	22.81	1.33	11.32	4.01	19.70	1.00	9.77	2.53	16.79
LF-IINet + SEIIF	3.42 0.02	19.61 0.73	2.83 0.03	21.19 1.62	1.30 0.03	10.62 0.70	3.95 0.06	19.10 0.60	0.81 0.19	8.87 0.90	2.46 0.07	15.88 0.91
LFT	3.54	20.14	3.02	23.23	1.39	11.62	4.03	19.87	0.89	9.45	2.58	16.86
LFT + SEIIF	3.42 0.12	19.10 1.04	2.98 0.04	22.06 1.17	1.39 0.00	10.83 0.79	3.91 0.12	18.80 1.07	0.75 0.14	8.83 0.62	2.49 0.09	15.92 0.94
DistgSSR	3.30	19.74	2.92	22.20	1.27	10.70	3.95	19.01	0.78	9.13	2.44	16.16
DistgSSR + SEIIF	3.34 0.04	18.87 0.87	2.82 0.10	21.37 0.83	1.25 0.02	10.24 0.46	3.87 0.08	18.29 0.72	0.66 0.12	8.81 0.32	2.39 0.05	15.52 0.64
HLFSR	2.99	18.93	2.37	20.99	1.28	10.51	3.57	18.56	0.63	8.87	2.17	15.57
HLFSR + SEIIF	2.95 0.04	17.94 0.99	2.29 0.08	20.90 0.09	1.24 0.04	10.37 0.14	3.60 0.03	17.56 1.00	0.54 0.09	7.30 1.57	2.12 0.05	14.81 0.76
EPIT	3.58	20.12	2.29	22.20	1.54	11.49	4.12	19.14	0.46	8.46	2.40	16.28
EPIT + SEIIF	3.46 0.12	19.36 0.76	2.26 0.03	21.18 1.02	1.32 0.22	10.46 1.03	3.91 0.21	18.40 0.74	0.38 0.08	7.46 1.00	2.27 0.13	15.37 0.91
LF-DET	2.88	19.27	2.33	21.75	1.42	11.06	3.70	18.91	0.51	8.47	2.17	15.89
LF-DET + SEIIF	2.95 0.07	17.66 1.61	2.32 0.01	20.51 1.24	1.38 0.04	10.41 0.65	3.63 0.07	17.69 1.22	0.51 0.00	7.21 1.26	2.16 0.01	14.69 1.20

single image arbitrary-scale super-resolution methods. These observations further prove that our SEIIF effectively exploits angular information to boost LFSSR with robust generalization performance and high computational efficiency. Note that since vanilla DistgSSR and EPIT are trained and verified for a specific scale, they also show remarkable results on 2×SR.

Table 3. Quantitative comparison in terms of average SSIM and LPIPS values for arbitrary-scale LFSSR. The best results are in bold and the second best results are underlined. All methods except baseline utilize one model for all scales with same parameters. OOM denotes out of memory on a single Tesla V100 GPU.

Method	Params(M)	SSIM / LPIPS (in-scale)			SSIM / LPIPS (out-of-scale)	
		×2	×3	×4	×6	×8
DistgSSR (Baseline)	[0.02, 0.07]	98.67 / 2.44	96.68 / 9.70	94.39 / 16.16	-	-
DistgSSR + LIIF	0.09	98.61 / 2.53	96.78 / 9.35	94.65 / 15.94	90.26 / 26.14	86.62 / 33.89
DistgSSR + LTE	0.13	98.63 / 2.57	96.79 / 9.34	94.66 / 15.90	90.31 / 25.79	86.67 / 33.42
DistgSSR + DIIF	0.12	98.63 / 2.56	96.80 / 9.35	94.67 / 15.98	<u>90.35</u> / 25.91	<u>86.67</u> / 33.56
DistgSSR + CiaoSR	0.22	<u>98.64</u> / 2.54	96.82 / 9.31	<u>94.68</u> / 15.90	90.34 / 25.56	OOM / OOM
DistgSSR + SEIIF (Ours)	0.12	<u>98.64</u> / <u>2.50</u>	<u>96.81</u> / 9.28	94.70 / 15.84	90.36 / 25.42	86.69 / 33.02
EPIT (Baseline)	[0.02, 0.07]	<u>98.69</u> / 2.40	96.75 / 9.69	94.52 / 16.28	-	-
EPIT + LIIF	0.09	<u>98.69</u> / 2.31	96.84 / 9.22	94.67 / 15.77	90.35 / 26.28	86.73 / 34.84
EPIT + LTE	0.13	<u>98.69</u> / 2.31	96.84 / 9.24	94.69 / 15.74	90.34 / 26.34	86.70 / 35.08
EPIT + DIIF	0.12	<u>98.69</u> / 2.41	96.84 / 9.32	94.70 / 15.83	90.38 / 26.42	<u>86.75</u> / <u>34.69</u>
EPIT + CiaoSR	0.22	98.70 / 2.27	96.87 / 9.14	<u>94.74</u> / 15.65	<u>90.43</u> / 25.99	OOM / OOM
EPIT + SEIIF (Ours)	0.12	98.70 / <u>2.29</u>	96.88 / 9.10	94.77 / 15.61	90.44 / 25.86	86.80 / 34.20