Meta-Transfer Learning for Zero-Shot Super-Resolution - Supplementary Material

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1. Evaluation on Scaling Factor $\times 4$

To evaluate the performance on large scaling factors, we demonstrate the results on scaling factor $\times 4$ with isotropic Gaussian kernel with width 2.0 in Table 1. As shown, our methods show comparable results to others even with one gradient update, for large scaling factors too. Also, we found that multi-scale model shows worse results than a single-scale model as evidenced in the scaling factor $\times 2$.

2. Effects of Kernels on Meta-test Time

To evaluate the effects of input kernels on meta-test time, we obtained several results by feeding various kernels. The results are shown in Figure 1. It is obvious that kernel mismatch degrades the output result severely. Especially, when the input kernel largely deviates from the true kernel, the result is not very pleasing as shown in Figure 1(a) and (b). However, if the input kernel has similar shape as the true kernel then the result looks quite plausible as shown in Figure 1(c). In conclusion, the kernel estimation or knowing the true kernel is crucial for the performance gain with our method.

3. Visualization

To show the effectiveness of our MZSR, we visualize some results including scenarios with synthetic blur kernels and real-world images. Figure 2, 3, and 4 are the results on synthetic blur kernels. Figure 5, 6, and 7 are the results on real-world images.

References

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[2] Jinjin Gu, Hannan Lu, Wangmeng Zuo, and Chao Dong. Blind super-resolution with iterative kernel correction. In *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2019. 2, 4, 5

[3] Assaf Shocher, Nadav Cohen, and Michal Irani. "zero-shot" super-resolution using deep internal learning. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 3118–3126, 2018. 2, 3, 4, 5

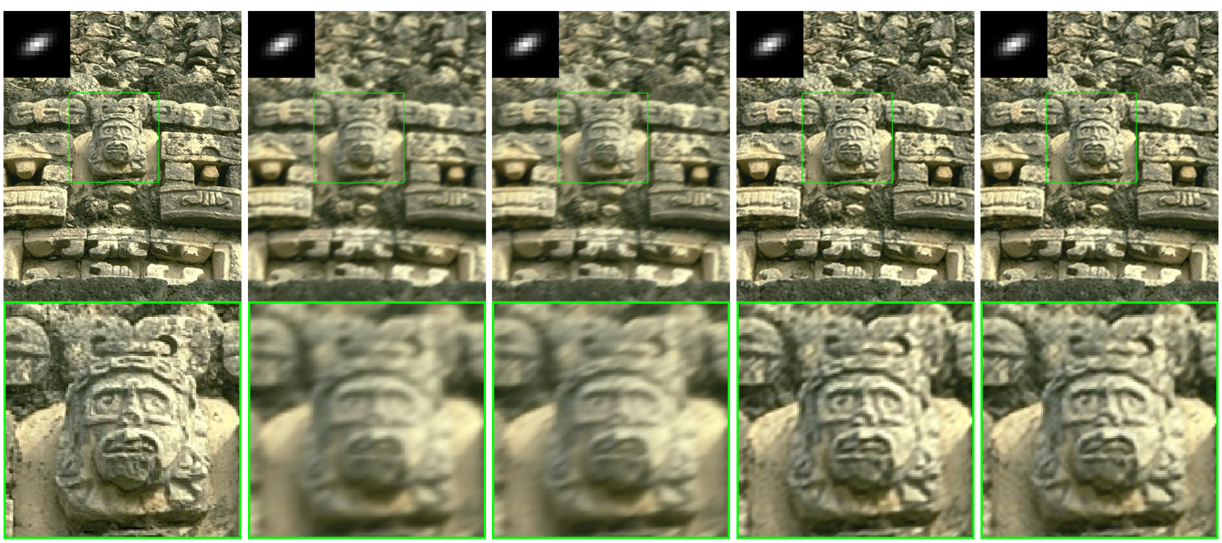
[4] Yulun Zhang, Kunpeng Li, Kai Li, Lichen Wang, Bineng Zhong, and Yun Fu. Image super-resolution using very deep residual channel attention networks. In *Proceedings of the European Conference on Computer Vision (ECCV)*, pages 286–301, 2018. 2, 3, 5

$g^d_{2.0}$	Supervised			Unsupervised			
Dataset	Bicubic	RCAN [4]	IKC [2]	ZSSR [3]	Multi-scale (1)	MZSR (1)	MZSR (10)
Set5	24.74/0.7321	23.92/0.7283	24.01/0.7322	27.39/0.7685	29.85/0.8601	30.20/0.8655	30.50/0.8704
BSD100	24.01/0.5998	23.16/0.5918	23.12/0.5939	25.89/0.6776	26.68/0.7136	26.73/0.7138	26.89/0.7168
Urban100	21.16/0.5811	19.52/0.5400	19.81/0.5583	23.53/0.6822	24.13/0.7251	24.36/0.7333	24.65/0.7394

Table 1: Average PSNR/SSIM results on the scaling factor $\times 4$ on benchmarks. The numbers in parenthesis in our methods stand for the number of gradient updates. The best and the second best are highlighted in red and blue, respectively.

(a) 21.40 dB (b) 19.52 dB (c) 27.95 dB (d) 24.52 dB (e) 24.32 dB (f) 30.31 dB

Figure 1: Comparisons when different kernels are applied on meta-test time. The last result is when the true kernel is applied.



GT | Bicubic | RCAN [4] | ZSSR [3] *2,160 updates* | MZSR (Ours) *10 updates*

Figure 2: Visualized comparisons of super-resolution results ($\times 2$) with anisotropic blur kernel g^d_{ani}.

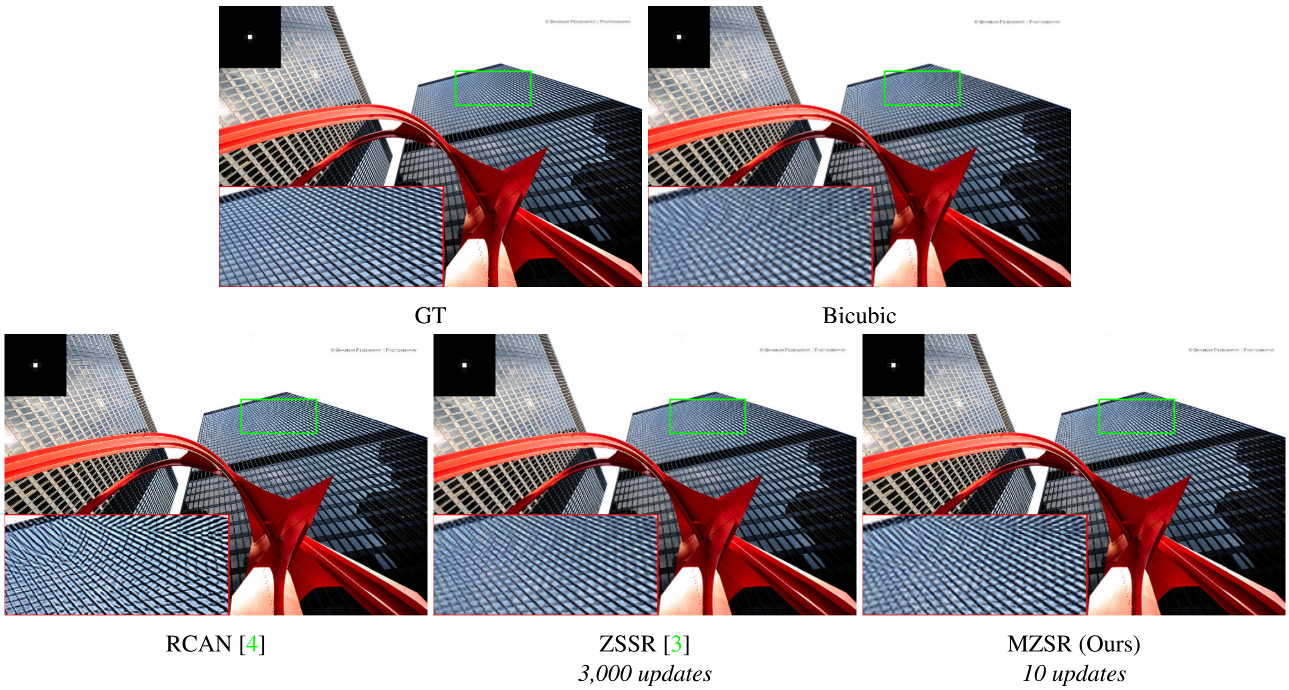


Figure 3: Visualized comparisons of super-resolution results ($\times 2$) with aliasing degradation $g^{d}_{0.2}$.

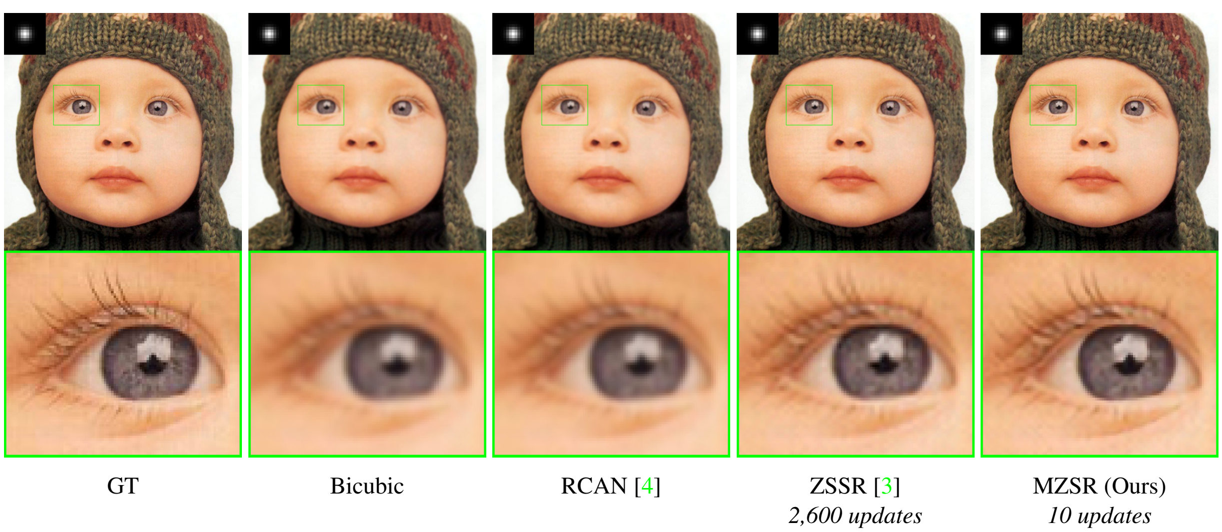
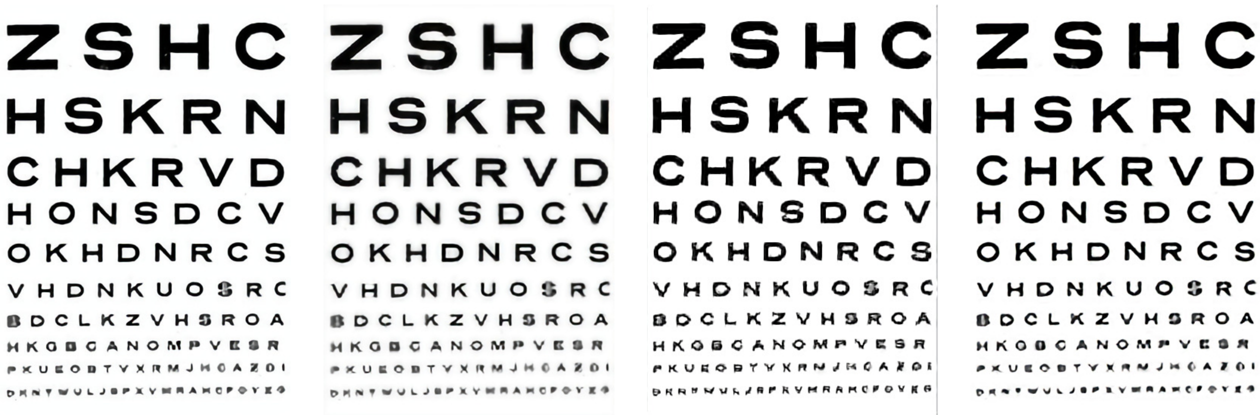


Figure 4: Visualized comparisons of super-resolution results ($\times 2$) with isotropic blur kernel and bicubic subsampling $g^{b}_{1.3}$.



CARN [1] | IKC [2] | ZSSR [3] *2,280 updates* | MZSR (Ours) *10 updates*

Figure 5: Visualized comparisons of super-resolution results (×4) on real-world image.

CARN [1] | IKC [2] | ZSSR [3] *1,500 updates* | MZSR (Ours) *10 updates*

Figure 6: Visualized comparisons of super-resolution results (×4) on real-world image.

CARN [1]

RCAN [4]

IKC [2]

ZSSR [3]
960 updates

MZSR (Ours)
10 updates

Figure 7: Visualized comparisons of super-resolution results ($\times 4$) on historic image.