

# SamplingAug: On the Importance of Patch Sampling Augmentation for Single Image Super-Resolution

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## 1 Detailed Experiments

In Fig. 1 and Fig. 2, we show more qualitative results of our method against the baselines. The qualitative comparison shows that all the SR networks benefit from our method and obtain visually better results.

In Tab. 1, we show the SSIM results on benchmarks. In Tab. 3, Tab. 4, Tab. 5, Tab. 6 and Tab. 7, we report the complete quantitative results with various baseline models (SRCNN [1], ESPCN [2], EDSR [3], RCAN [4] and RDN [5]) under different scaling factors on different datasets (DIV2K [6], Set5 [7], Set14 [8], B100 [9] and Urban100 [10]). Peak Signal-to-Noise Ratio (PSNR) is adopted as the evaluation metric to measure SR performance. All the results show that our method can yield a consistent and significant performance boost.

We also evaluate LPIPS [11] results on benchmarks in Tab. 2. As can be seen, our approach also improves the performance of baselines in terms of perceptual metrics. Note that lower LPIPS means better perceptual quality.

Networks	scale	Set5	Set14	B100	Urban100
SRCNN	x2	0.9185 (+0.0214)	0.8610 (+0.0307)	0.8615 (+0.0334)	0.8463 (+0.0321)
	x3	0.8536 (+0.0136)	0.7691 (+0.0182)	0.7471 (+0.0173)	0.7374 (+0.0162)
	x4	0.7929 (+0.0131)	0.6979 (+0.0138)	0.6686 (+0.0112)	0.6562 (+0.0122)
ESPCN	x2	0.8900 (+0.0711)	0.8345 (+0.0722)	0.8510 (+0.0624)	0.8272 (+0.0684)
	x3	0.7794 (+0.0738)	0.7099 (+0.0678)	0.7178 (+0.0598)	0.6954 (+0.0662)
	x4	0.6814 (+0.0779)	0.6108 (+0.0682)	0.6201 (+0.0567)	0.5905 (+0.0604)
EDSR	x2	0.9398 (+0.0028)	0.8895 (+0.0046)	0.8833 (+0.0044)	0.8987 (+0.0126)
	x3	0.8852 (+0.0047)	0.7963 (+0.0031)	0.7691 (+0.0021)	0.7880 (+0.0103)
	x4	0.8318 (+0.0091)	0.7268 (+0.0063)	0.6891 (+0.0038)	0.7032 (+0.0121)
RCAN	x2	0.9364 (+0.0013)	0.8846 (+0.0016)	0.8789 (+0.0011)	0.8857 (+0.0034)
	x3	0.8792 (+0.0106)	0.7919 (+0.0076)	0.7659 (+0.0063)	0.7777 (+0.0164)
	x4	0.8223 (+0.0172)	0.7201 (+0.0124)	0.6852 (+0.0083)	0.6914 (+0.0180)
RDN	x2	0.9394 (+0.0008)	0.8881 (+0.0018)	0.8829 (+0.0020)	0.8962 (+0.0055)
	x3	0.8875 (+0.0043)	0.7981 (+0.0032)	0.7728 (+0.0032)	0.7920 (+0.0102)
	x4	0.8323 (+0.0094)	0.7279 (+0.0078)	0.6911 (+0.0046)	0.7065 (+0.0141)

Table 1: Quantitative Results (SSIM) on Benchmarks. We omit the results of baselines for simplicity, and only report our results and the gain margins.

Networks	scale	Set5	Set14	B100	Urban100
SRCNN	x2	0.006(-0.004)	0.019(-0.008)	0.027(-0.011)	0.042(-0.014)
	x3	0.008(-0.002)	0.034(-0.005)	0.043(-0.005)	0.063(-0.007)
	x4	0.021(-0.003)	0.054(-0.006)	0.068(-0.005)	0.100(-0.008)
ESPCN	x2	0.007(-0.004)	0.019(-0.009)	0.025(-0.009)	0.040(-0.012)
	x3	0.010(-0.003)	0.035(-0.005)	0.043(-0.006)	0.063(-0.010)
	x4	0.024(-0.006)	0.057(-0.006)	0.067(-0.005)	0.100(-0.010)
EDSR	x2	0.003(-0.001)	0.012(-0.001)	0.018(-0.002)	0.023(-0.005)
	x3	0.005(-0.001)	0.026(-0.002)	0.034(-0.003)	0.046(-0.005)
	x4	0.015(-0.002)	0.045(-0.003)	0.060(-0.003)	0.083(-0.007)
RCAN	x2	0.003(-0.001)	0.013(-0.001)	0.020(-0.001)	0.027(-0.002)
	x3	0.005(-0.002)	0.028(-0.003)	0.036(-0.003)	0.049(-0.007)
	x4	0.017(-0.002)	0.047(-0.004)	0.062(-0.003)	0.088(-0.007)
RDN	x2	0.003(-0.001)	0.013(-0.001)	0.019(-0.001)	0.024(-0.003)
	x3	0.005(-0.001)	0.026(-0.002)	0.034(-0.002)	0.046(-0.005)
	x4	0.014(-0.003)	0.044(-0.003)	0.059(-0.004)	0.083(-0.007)

Table 2: LPIPS results on Benchmarks. We omit the results of baselines for simplicity, and only report our results and the gain margins.

Network	Scale	Portion	DIV2K	Set5	Set14	B100	Urban100
SRCNN	x2	baseline	31.62	33.53	30.51	29.59	26.89
		0.5	32.55 (+0.93)	34.46 (+0.93)	31.24 (+0.73)	30.16 (+0.57)	27.47 (+0.58)
		0.3	32.68 (+1.06)	34.59 (+1.06)	31.35 (+0.84)	30.27 (+0.68)	27.57 (+0.68)
		0.1	32.86 (+1.24)	34.76 (+1.23)	31.48 (+0.97)	30.38 (+0.79)	27.68 (+0.79)
		1e-2	32.94 (+1.32)	34.87 (+1.34)	31.57 (+1.06)	30.44 (+0.85)	27.75 (+0.86)
		1e-3	32.98 (+1.36)	34.92 (+1.39)	31.60 (+1.09)	30.46 (+0.87)	27.77 (+0.88)
		1e-4	33.00 (+1.38)	34.93 (+1.40)	31.61 (+1.10)	30.47 (+0.88)	27.78 (+0.89)
		1e-5	33.00 (+1.38)	34.93 (+1.40)	31.61 (+1.10)	30.46 (+0.87)	27.78 (+0.89)
		1e-6	33.00 (+1.38)	34.94 (+1.41)	31.62 (+1.11)	30.47 (+0.88)	27.79 (+0.90)
	x3	baseline	29.22	30.90	28.20	27.51	24.78
		0.5	29.52 (+0.30)	31.19 (+0.29)	28.43 (+0.23)	27.66 (+0.15)	24.94 (+0.16)
		0.3	29.56 (+0.34)	31.25 (+0.35)	28.49 (+0.29)	27.69 (+0.18)	24.98 (+0.20)
		0.1	29.62 (+0.40)	31.33 (+0.43)	28.56 (+0.36)	27.74 (+0.23)	25.03 (+0.25)
		1e-2	29.65 (+0.43)	31.37 (+0.47)	28.60 (+0.40)	27.77 (+0.26)	25.06 (+0.28)
		1e-3	29.67 (+0.45)	31.36 (+0.46)	28.60 (+0.40)	27.76 (+0.25)	25.05 (+0.27)
		1e-4	29.67 (+0.45)	31.36 (+0.46)	28.59 (+0.39)	27.76 (+0.25)	25.05 (+0.27)
		1e-5	29.67 (+0.45)	31.37 (+0.47)	28.60 (+0.40)	27.77 (+0.26)	25.06 (+0.28)
		1e-6	29.67 (+0.45)	31.37 (+0.47)	28.60 (+0.40)	27.76 (+0.25)	25.05 (+0.27)
	x4	baseline	27.64	28.98	26.61	26.26	23.46
		0.5	27.82 (+0.18)	29.20 (+0.22)	26.79 (+0.18)	26.35 (+0.09)	23.57 (+0.11)
		0.3	27.84 (+0.20)	29.20 (+0.22)	26.79 (+0.18)	26.35 (+0.09)	23.57 (+0.11)
		0.1	27.88 (+0.24)	29.26 (+0.28)	26.85 (+0.24)	26.38 (+0.12)	23.60 (+0.14)
		1e-2	27.91 (+0.27)	29.30 (+0.32)	26.88 (+0.27)	26.40 (+0.14)	23.62 (+0.16)
		1e-3	27.92 (+0.28)	29.32 (+0.34)	26.90 (+0.29)	26.41 (+0.15)	23.63 (+0.17)
		1e-4	27.93 (+0.29)	29.32 (+0.34)	26.90 (+0.29)	26.42 (+0.16)	23.63 (+0.17)
		1e-5	27.93 (+0.29)	29.31 (+0.33)	26.90 (+0.29)	26.41 (+0.15)	23.63 (+0.17)
		1e-6	27.93 (+0.29)	29.33 (+0.35)	26.91 (+0.30)	26.42 (+0.16)	23.63 (+0.17)

Table 3: Quantitative results of SRCNN

Network	Scale	Portion	DIV2K	Set5	Set14	B100	Urban100
ESPCN	x2	baseline	29.24	31.79	29.23	29.14	26.34
		0.5	31.03 (+1.79)	33.39 (+1.60)	30.60 (+1.37)	30.01 (+0.87)	27.24 (+0.90)
		0.3	31.34 (+2.10)	33.64 (+1.85)	30.79 (+1.56)	30.13 (+0.99)	27.37 (+1.03)
		0.1	31.52 (+2.28)	33.82 (+2.03)	30.95 (+1.72)	30.23 (+1.09)	27.49 (+1.15)
		1e-2	31.72 (+2.48)	33.98 (+2.19)	31.07 (+1.84)	30.33 (+1.19)	27.59 (+1.25)
		1e-3	31.78 (+2.54)	34.05 (+2.26)	31.14 (+1.91)	30.36 (+1.22)	27.64 (+1.30)
		1e-4	31.77 (+2.53)	34.05 (+2.26)	31.14 (+1.91)	30.36 (+1.22)	27.64 (+1.30)
		1e-5	31.78 (+2.54)	34.05 (+2.26)	31.14 (+1.91)	30.36 (+1.22)	27.64 (+1.30)
		1e-6	31.77 (+2.53)	34.05 (+2.26)	31.14 (+1.91)	30.36 (+1.22)	27.64 (+1.30)
	x3	baseline	26.98	29.01	26.86	26.81	24.00
		0.5	27.71 (+0.73)	29.77 (+0.76)	27.44 (+0.58)	27.19 (+0.38)	24.41 (+0.41)
		0.3	27.90 (+0.92)	29.97 (+0.96)	27.59 (+0.73)	27.29 (+0.48)	24.52 (+0.52)
		0.1	28.09 (+1.11)	30.16 (+1.15)	27.76 (+0.90)	27.39 (+0.58)	24.64 (+0.64)
		1e-2	28.20 (+1.22)	30.30 (+1.29)	27.88 (+1.02)	27.47 (+0.66)	24.73 (+0.73)
		1e-3	28.25 (+1.27)	30.35 (+1.34)	27.92 (+1.06)	27.50 (+0.69)	24.75 (+0.75)
		1e-4	28.25 (+1.27)	30.35 (+1.34)	27.92 (+1.06)	27.50 (+0.69)	24.76 (+0.76)
		1e-5	28.27 (+1.29)	30.36 (+1.35)	27.93 (+1.07)	27.50 (+0.69)	24.76 (+0.76)
		1e-6	28.27 (+1.29)	30.36 (+1.35)	27.93 (+1.07)	27.50 (+0.69)	24.76 (+0.76)
	x4	baseline	25.36	26.94	25.24	25.46	22.60
		0.5	26.01 (+0.66)	27.69 (+0.75)	25.77 (+0.53)	25.83 (+0.37)	23.00 (+0.40)
		0.3	26.19 (+0.84)	27.88 (+0.94)	25.91 (+0.67)	25.94 (+0.48)	23.10 (+0.50)
		0.1	26.32 (+0.96)	28.07 (+1.13)	26.03 (+0.79)	26.03 (+0.57)	23.19 (+0.59)
		1e-2	26.33 (+0.97)	28.16 (+1.22)	26.09 (+0.85)	26.07 (+0.61)	23.25 (+0.65)
		1e-3	26.34 (+0.98)	28.19 (+1.25)	26.12 (+0.88)	26.10 (+0.64)	23.27 (+0.67)
		1e-4	26.35 (+0.99)	28.19 (+1.25)	26.13 (+0.89)	26.10 (+0.64)	23.27 (+0.67)
		1e-5	26.35 (+0.99)	28.20 (+1.26)	26.13 (+0.89)	26.10 (+0.64)	23.28 (+0.68)
		1e-6	26.35 (+0.99)	28.20 (+1.26)	26.13 (+0.89)	26.10 (+0.64)	23.28 (+0.68)

Table 4: Quantitative results of ESPCN

Network	Scale	Portion	DIV2K	Set5	Set14	B100	Urban100
EDSR	x2	baseline	34.56	36.87	32.97	31.41	29.60
		0.5	34.67 (+0.11)	37.04 (+0.17)	33.10 (+0.13)	31.50 (+0.09)	29.89 (+0.29)
		0.3	34.68 (+0.12)	37.05 (+0.18)	33.12 (+0.15)	31.52 (+0.11)	29.95 (+0.35)
		0.1	34.68 (+0.12)	37.08 (+0.21)	33.15 (+0.18)	31.52 (+0.11)	30.02 (+0.42)
		1e-2	34.64 (+0.08)	37.27 (+0.40)	33.38 (+0.41)	31.68 (+0.27)	30.46 (+0.86)
		1e-3	34.62 (+0.06)	37.01 (+0.14)	33.14 (+0.17)	31.50 (+0.09)	30.04 (+0.44)
		1e-4	34.61 (+0.05)	36.96 (+0.09)	33.12 (+0.15)	31.49 (+0.08)	30.03 (+0.43)
		1e-5	34.60 (+0.04)	36.96 (+0.09)	33.14 (+0.17)	31.50 (+0.09)	30.02 (+0.42)
		1e-6	34.62 (+0.06)	37.00 (+0.13)	33.15 (+0.18)	31.50 (+0.09)	30.03 (+0.43)
	x3	baseline	30.60	32.69	29.61	28.36	26.09
		0.5	30.73 (+0.13)	32.95 (+0.26)	29.79 (+0.18)	28.46 (+0.10)	26.33 (+0.24)
		0.3	30.75 (+0.15)	33.01 (+0.32)	29.82 (+0.21)	28.48 (+0.12)	26.39 (+0.30)
		0.1	30.75 (+0.15)	33.02 (+0.33)	29.86 (+0.25)	28.49 (+0.13)	26.44 (+0.35)
		1e-2	30.71 (+0.11)	33.01 (+0.32)	29.84 (+0.23)	28.47 (+0.11)	26.42 (+0.33)
		1e-3	30.69 (+0.09)	33.03 (+0.34)	29.84 (+0.23)	28.47 (+0.11)	26.44 (+0.35)
		1e-4	30.69 (+0.09)	33.02 (+0.33)	29.84 (+0.23)	28.47 (+0.11)	26.42 (+0.33)
		1e-5	30.68 (+0.08)	33.00 (+0.31)	29.85 (+0.24)	28.47 (+0.11)	26.42 (+0.33)
		1e-6	30.68 (+0.08)	32.93 (+0.24)	29.81 (+0.20)	28.46 (+0.10)	26.39 (+0.30)
	x4	baseline	28.55	30.33	27.62	26.83	24.31
		0.5	28.68 (+0.13)	30.58 (+0.25)	27.84 (+0.22)	26.92 (+0.09)	24.50 (+0.19)
		0.3	28.68 (+0.13)	30.61 (+0.28)	27.88 (+0.26)	26.93 (+0.10)	24.54 (+0.23)
		0.1	28.69 (+0.14)	30.67 (+0.34)	27.91 (+0.29)	26.94 (+0.11)	24.57 (+0.26)
		1e-2	28.66 (+0.11)	30.66 (+0.33)	27.93 (+0.31)	26.94 (+0.11)	24.58 (+0.27)
		1e-3	28.63 (+0.08)	30.62 (+0.29)	27.90 (+0.28)	26.93 (+0.10)	24.57 (+0.26)
		1e-4	28.63 (+0.08)	30.61 (+0.28)	27.89 (+0.27)	26.94 (+0.11)	24.57 (+0.26)
		1e-5	28.62 (+0.07)	30.58 (+0.25)	27.90 (+0.28)	26.93 (+0.10)	24.56 (+0.25)
		1e-6	28.62 (+0.07)	30.58 (+0.25)	27.90 (+0.28)	26.93 (+0.10)	24.56 (+0.25)

Table 5: Quantitative results of EDSR

Network	Scale	Portion	DIV2K	Set5	Set14	B100	Urban100
RCAN	x2	baseline	34.59	36.70	32.89	31.33	29.42
		0.5	34.77 (+0.18)	36.77 (+0.07)	32.91 (+0.02)	31.35 (+0.02)	29.48 (+0.06)
		0.3	34.79 (+0.20)	34.83 (+0.13)	32.97 (+0.08)	31.38 (+0.05)	29.56 (+0.14)
		0.1	34.77 (+0.18)	36.85 (+0.15)	32.97 (+0.08)	31.39 (+0.06)	29.62 (+0.20)
		1e-2	34.73 (+0.14)	36.81 (+0.11)	32.96 (+0.07)	31.39 (+0.06)	29.65 (+0.23)
		1e-3	34.73 (+0.14)	36.81 (+0.11)	32.96 (+0.07)	31.38 (+0.05)	29.65 (+0.23)
		1e-4	34.72 (+0.13)	36.81 (+0.11)	32.98 (+0.09)	31.38 (+0.05)	29.65 (+0.23)
		1e-5	34.72 (+0.13)	36.83 (+0.13)	32.97 (+0.08)	31.39 (+0.06)	29.67 (+0.25)
		1e-6	34.72 (+0.13)	36.81 (+0.11)	32.97 (+0.08)	31.38 (+0.05)	29.66 (+0.24)
	x3	baseline	30.64	32.14	29.22	28.12	25.66
		0.5	30.77 (+0.13)	32.60 (+0.46)	29.50 (+0.28)	28.30 (+0.18)	26.00 (+0.34)
		0.3	30.78 (+0.14)	32.66 (+0.52)	29.54 (+0.32)	28.33 (+0.21)	26.05 (+0.39)
		0.1	30.79 (+0.15)	32.70 (+0.56)	29.62 (+0.40)	28.35 (+0.23)	26.14 (+0.48)
		1e-2	30.77 (+0.13)	32.72 (+0.58)	29.62 (+0.40)	28.35 (+0.23)	26.16 (+0.50)
		1e-3	30.74 (+0.10)	32.70 (+0.56)	29.62 (+0.40)	28.35 (+0.23)	26.15 (+0.49)
		1e-4	30.74 (+0.10)	32.69 (+0.55)	29.62 (+0.40)	28.35 (+0.23)	26.16 (+0.50)
		1e-5	30.74 (+0.10)	32.68 (+0.54)	29.62 (+0.40)	28.35 (+0.23)	26.16 (+0.50)
		1e-6	30.74 (+0.10)	32.71 (+0.57)	29.61 (+0.39)	28.34 (+0.22)	26.16 (+0.50)
	x4	baseline	28.53	29.88	27.26	26.65	24.01
		0.5	28.66 (+0.13)	30.25 (+0.37)	27.57 (+0.31)	26.80 (+0.15)	24.27 (+0.26)
		0.3	28.67 (+0.14)	30.32 (+0.44)	27.63 (+0.37)	26.83 (+0.18)	24.33 (+0.32)
		0.1	28.68 (+0.15)	30.35 (+0.47)	27.68 (+0.42)	26.83 (+0.18)	24.37 (+0.36)
		1e-2	28.66 (+0.13)	30.34 (+0.46)	27.69 (+0.43)	26.83 (+0.18)	24.37 (+0.36)
		1e-3	28.65 (+0.12)	30.34 (+0.46)	27.68 (+0.42)	26.82 (+0.17)	24.37 (+0.36)
		1e-4	28.64 (+0.11)	30.31 (+0.43)	27.68 (+0.42)	26.82 (+0.17)	24.37 (+0.36)
		1e-5	28.64 (+0.11)	30.32 (+0.44)	27.67 (+0.41)	26.82 (+0.17)	24.37 (+0.36)
		1e-6	28.63 (+0.10)	30.30 (+0.42)	27.67 (+0.41)	26.82 (+0.17)	24.36 (+0.35)

Table 6: Quantitative results of RCAN

Network	Scale	Portion	DIV2K	Set5	Set14	B100	Urban100
RDN	x2	baseline	34.45	37.13	33.13	31.54	29.84
		0.5	34.50 (+0.05)	37.24 (+0.11)	33.26 (+0.13)	31.62 (+0.08)	30.08 (+0.24)
		0.3	34.53 (+0.07)	37.26 (+0.13)	33.27 (+0.14)	31.65 (+0.11)	30.16 (+0.32)
		0.1	34.55 (+0.10)	37.20 (+0.07)	33.25 (+0.12)	31.65 (+0.11)	30.22 (+0.38)
		1e-2	34.52 (+0.07)	37.15 (+0.02)	33.21 (+0.08)	31.64 (+0.10)	30.18 (+0.34)
		1e-3	34.50 (+0.05)	37.12 (-0.01)	33.22 (+0.09)	31.65 (+0.11)	30.19 (+0.35)
		1e-4	34.49 (+0.04)	37.13 (+0.00)	33.25 (+0.12)	31.64 (+0.10)	30.22 (+0.38)
		1e-5	34.50 (+0.05)	37.11 (-0.02)	33.23 (+0.10)	31.64 (+0.10)	30.21 (+0.37)
		1e-6	34.49 (+0.04)	37.13 (+0.00)	33.23 (+0.10)	31.63 (+0.09)	30.20 (+0.36)
	x3	baseline	30.26	32.82	29.69	28.42	26.17
		0.5	30.52 (+0.26)	33.03 (+0.21)	29.83 (+0.14)	28.51 (+0.09)	26.38 (+0.21)
		0.3	30.55 (+0.29)	33.08 (+0.26)	29.86 (+0.17)	28. (+0.11)	24.88 (+0.25)
		0.1	30.58 (+0.32)	33.06 (+0.24)	29.85 (+0.16)	28.55 (+0.13)	26.47 (+0.30)
		1e-2	30.56 (+0.30)	33.15 (+0.33)	29.87 (+0.18)	28.57 (+0.15)	26.51 (+0.34)
		1e-3	30.54 (+0.28)	33.13 (+0.31)	29.86 (+0.17)	28.56 (+0.14)	26.49 (+0.32)
		1e-4	30.54 (+0.28)	33.13 (+0.31)	29.87 (+0.18)	28.55 (+0.13)	26.48 (+0.31)
		1e-5	30.54 (+0.28)	33.13 (+0.31)	29.87 (+0.18)	28.55 (+0.13)	26.49 (+0.32)
		1e-6	30.53 (+0.27)	33.09 (+0.27)	29.85 (+0.16)	28.55 (+0.13)	26.46 (+0.29)
	x4	baseline	28.29	30.35	27.68	26.84	24.32
		0.5	28.50 (+0.21)	30.59 (+0.24)	27.87 (+0.19)	26.93 (+0.09)	24.50 (+0.18)
		0.3	28.53 (+0.24)	30.63 (+0.28)	27.92 (+0.24)	26.95 (+0.11)	24.54 (+0.22)
		0.1	28.55 (+0.26)	30.68 (+0.33)	27.96 (+0.28)	26.97 (+0.13)	24.60 (+0.28)
		1e-2	28.53 (+0.24)	30.67 (+0.32)	27.97 (+0.29)	26.99 (+0.15)	24.61 (+0.29)
		1e-3	28.51 (+0.22)	30.69 (+0.34)	27.99 (+0.31)	26.99 (+0.15)	24.62 (+0.30)
		1e-4	28.51 (+0.22)	30.66 (+0.31)	27.99 (+0.31)	26.99 (+0.15)	24.63 (+0.31)
		1e-5	28.50 (+0.21)	30.69 (+0.34)	28.00 (+0.32)	26.99 (+0.15)	24.63 (+0.31)
		1e-6	28.50 (+0.21)	30.67 (+0.32)	27.98 (+0.30)	26.98 (+0.14)	24.61 (+0.29)

Table 7: Quantitative results of RDN

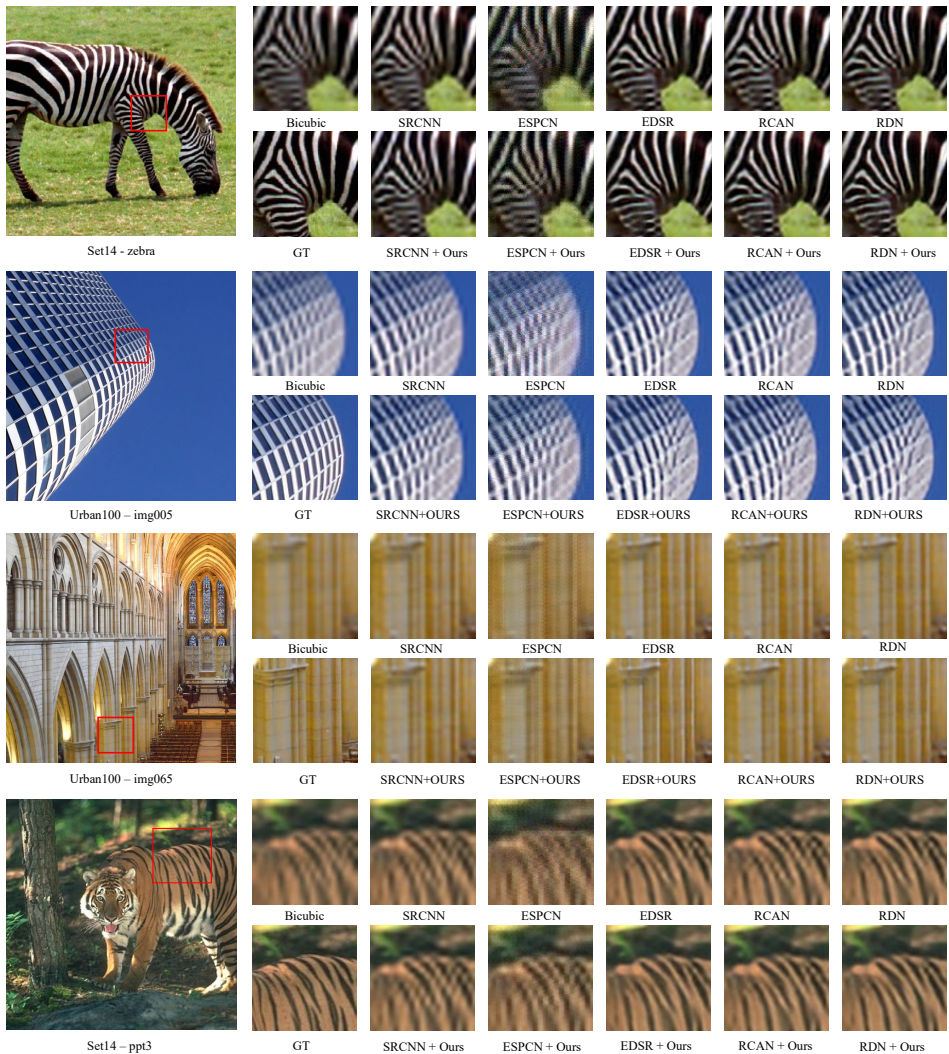


Figure 1: More qualitative comparison between our method and baselines.



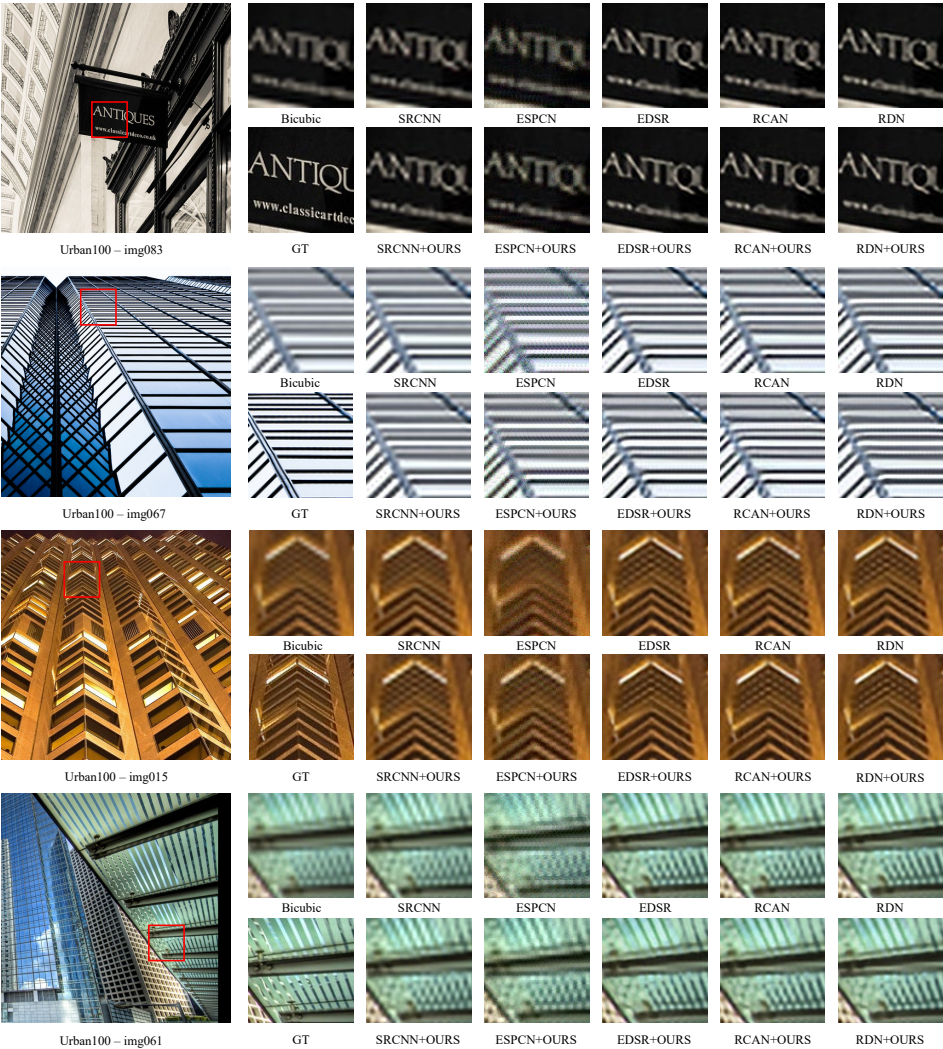


Figure 2: More qualitative comparison between our method and baselines.

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