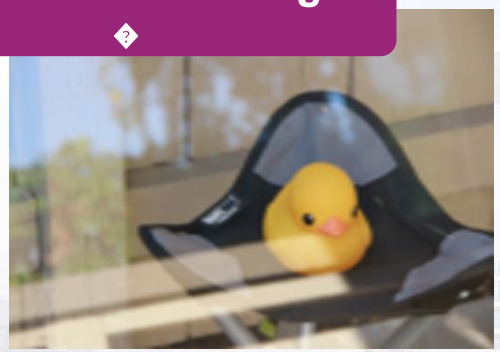

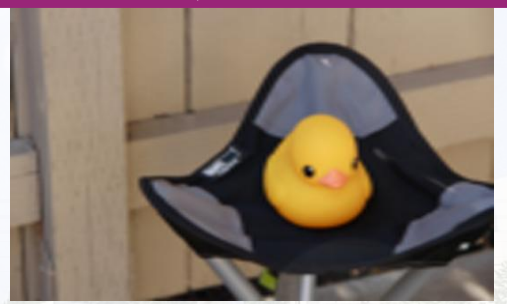

Robust Single Image Reflection Removal Against Adversarial Attacks

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1.The Single Image Reflection Removal Problem

南京理工大学 NANJING UNIVERSITY OF SCIENCE & TECHNOLOGY

SIRR

$$I = \alpha T + (1 - \alpha) R$$

I

T

Adversarial attack objectives and regions

$$I' = I + R \cdot \delta, \tag{1}$$

$$\delta = arg \max_{\|\delta\| \leq \epsilon} O(f(I), f(I')) \tag{2}$$

Attack Model： PGD

Attack Objectives：

1）MSE：$O = \|f(I) - f(I')\|_2$.

2）LPIPS：$O = \ell_{lpips}(f(I), f(I'))$.

Attack Region：

1）Full Region. $R = \mathbf{1}$.

2）Reflection Region. $R = abs(f(I) - I) > \theta$.

3）Non-reflection Region. $R = abs(f(I) - I) \leq \theta$.

Perturbation Level： $\delta \in \{0,1,2,4,8\}/255$

3. Robustness Evaluation

Visual Results

[1] Kaixuan Wei, Jiaolong Yang, Ying Fu, David Wipf, and Hua Huang. Single image reflection removal exploiting misaligned training data and network enhancements. In IEEE Conference on Computer Vision and Pattern Recognition, 2019

[2] Qiang Wen, Yinjie Tan, Jing Qin, Wenxi Liu, Guoqiang Han, and Shengfeng He. Single image reflection removal beyond linearity. In IEEE Conference on Computer Vision and Pattern Recognition，2019.

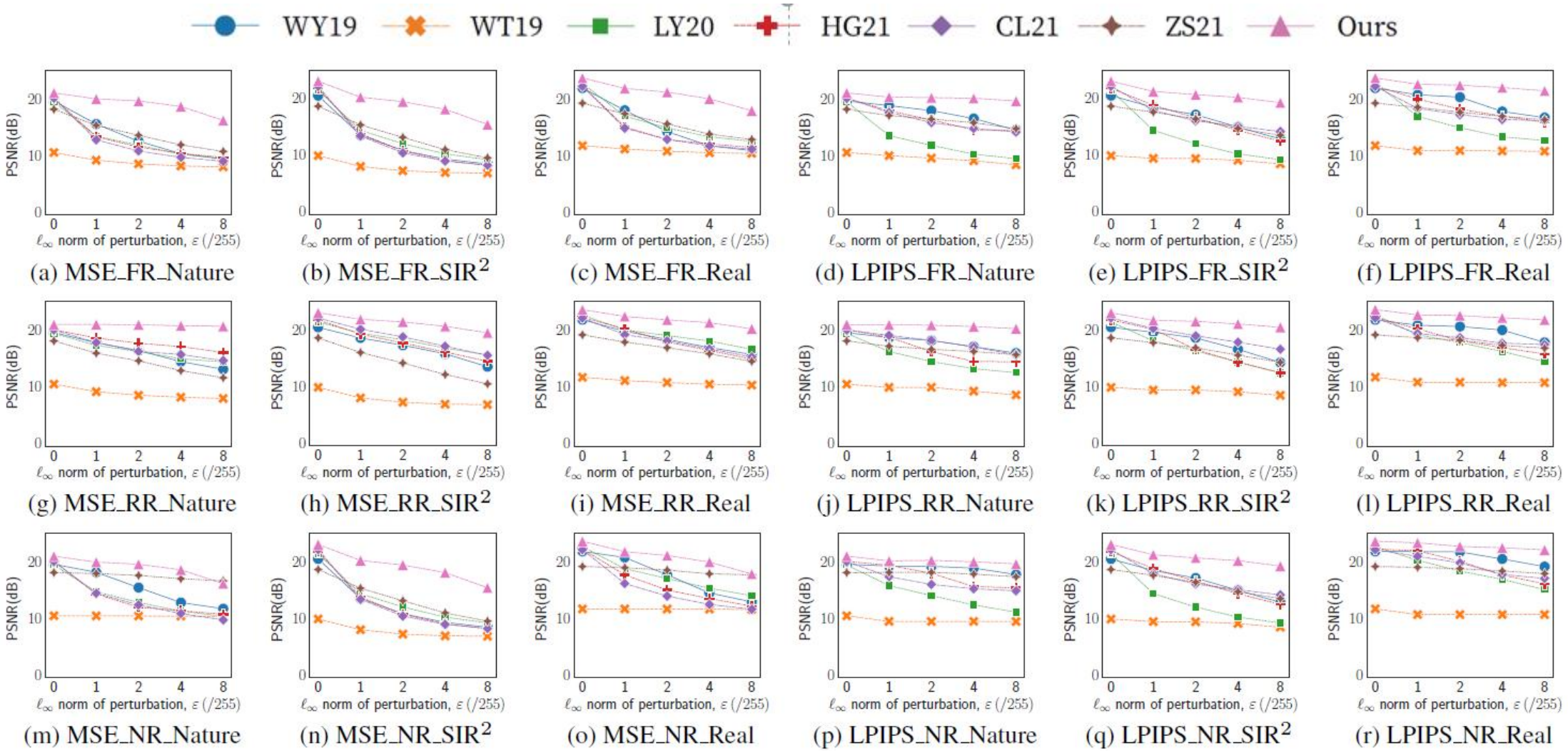
[3] Chao Li, Yixiao Yang, Kun He, Stephen Lin, and John E. Hopcroft. Single image reflection removal through cascaded refinement. In IEEE Conference on Computer Vision and Pattern Recognition, 2020.

[4] Qiming Hu and Xiaojie Guo. Trash or Treasure? An Interactive Dual-Stream Strategy for Single Image Reflection Separation. Advances in Neural Information Processing Systems, 2021.

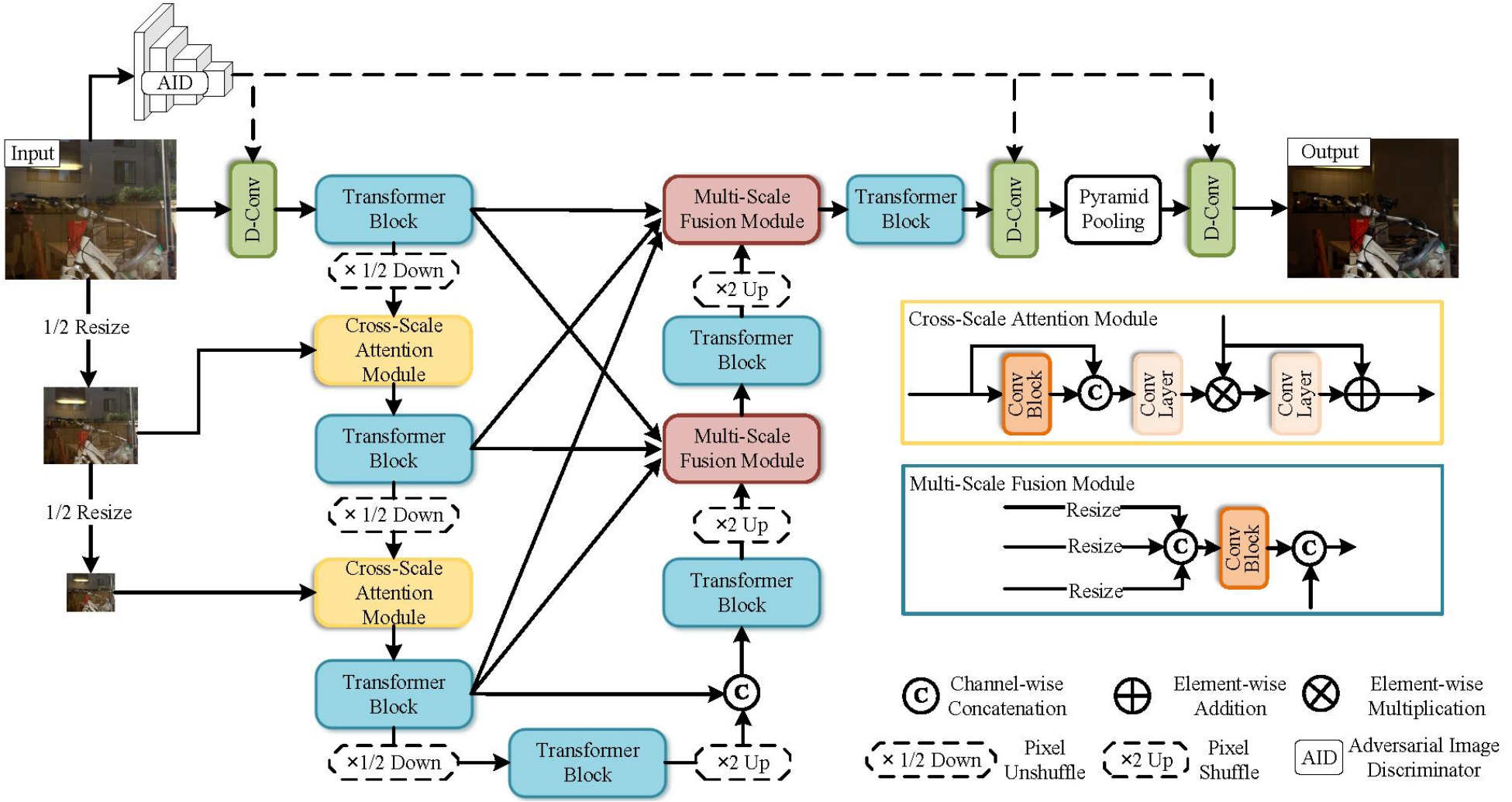
[5] Ya-Chu Chang, Chia-Ni Lu, Chia-Chi Cheng, and Wei-Chen Chiu. Single image reflection removal with edge guidance, reflection classifier, and recurrent decomposition. In IEEE Conference on Computer Vision and Pattern Recognition, 2021.

[6] Qian Zheng, Boxin Shi, Jinnan Chen, Xudong Jiang, Ling-Yu Duan, and Alex C. Kot. Single image reflection removal with absorption effect. In IEEE Conference on Computer Vision and Pattern Recognition, 2021.

3. Robustness Evaluation



4. The Proposed Model

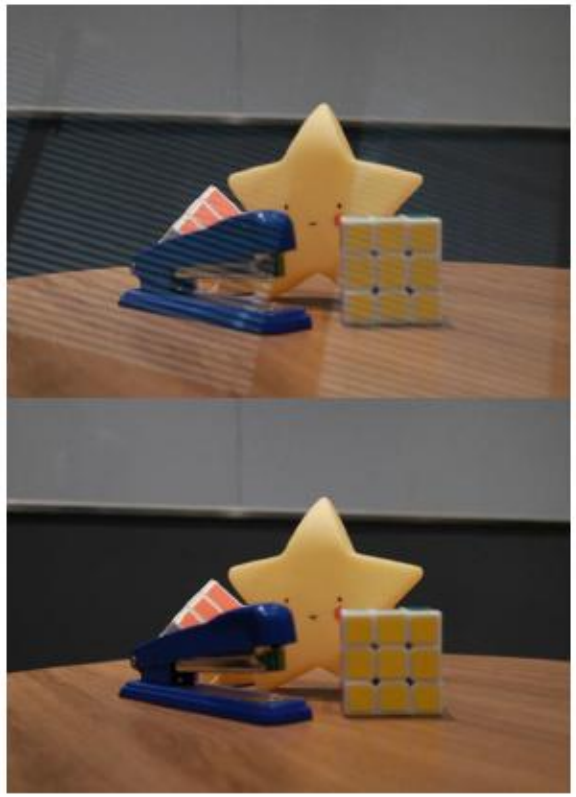


4. The Results of the Proposed Model

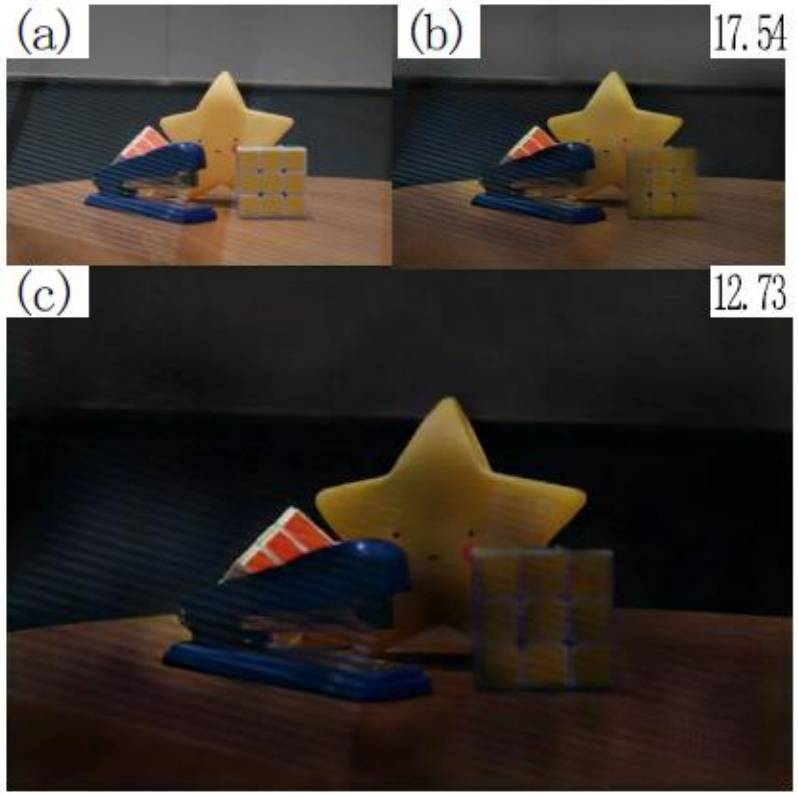
		Nature		SIR^2		Real	
		PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
WY19 [1] w/o adv.	Clean	19.54	0.738	20.45	0.853	21.82	0.812
	MSE	11.86 ↓7.68	0.361 ↓0.377	10.49 ↓9.97	0.410 ↓0.442	13.61 ↓8.21	0.388 ↓0.424
	LPIPS	16.85 ↓2.69	0.588 ↓0.149	15.81 ↓4.65	0.677 ↓0.176	18.79 ↓3.04	0.639 ↓0.173
WY19 [1] w/ adv.	Clean	17.28 ↓2.26	0.670 ↓0.067	17.97 ↓2.49	0.832 ↓0.021	19.23 ↓2.59	0.752 ↓0.060
	MSE	16.08 ↓3.46	0.613 ↓0.125	16.54 ↓3.92	0.769 ↓0.083	18.61 ↓3.21	0.718 ↓0.094
	LPIPS	17.01 ↓2.53	0.633 ↓0.105	17.49 ↓2.96	0.779 ↓0.074	16.64 ↓5.18	0.702 ↓0.110
Ours w/o adv.	Clean	20.33	0.758	**23.43**	**0.894**	22.26	0.826
	MSE	10.35 ↓9.98	0.264 ↓0.494	9.18 ↓14.24	0.317 ↓0.577	11.92 ↓10.34	0.274 ↓0.552
	LPIPS	15.15 ↓5.18	0.560 ↓0.198	14.84 ↓8.59	0.645 ↓0.250	16.38 ↓5.88	0.573 ↓0.253
Ours w/ adv.	Clean	**20.97** ↑0.64	**0.764** ↑0.006	23.02 ↓0.41	0.892 ↓0.002	**23.61** ↑1.35	**0.835** ↑0.009
	MSE	18.53 ↓1.79	0.726 ↓0.032	18.25 ↓5.17	0.821 ↓0.073	20.15 ↓2.11	0.752 ↓0.074
	LPIPS	19.98 ↓0.35	0.732 ↓0.026	20.31 ↓3.12	0.830 ↓0.064	22.02 ↓0.24	0.768 ↓0.058

[1] Kaixuan Wei, Jiaolong Yang, Ying Fu, David Wipf, and Hua Huang. Single image reflection removal exploiting misaligned training data and network enhancements. In IEEE Conference on Computer Vision and Pattern Recognition, 2019

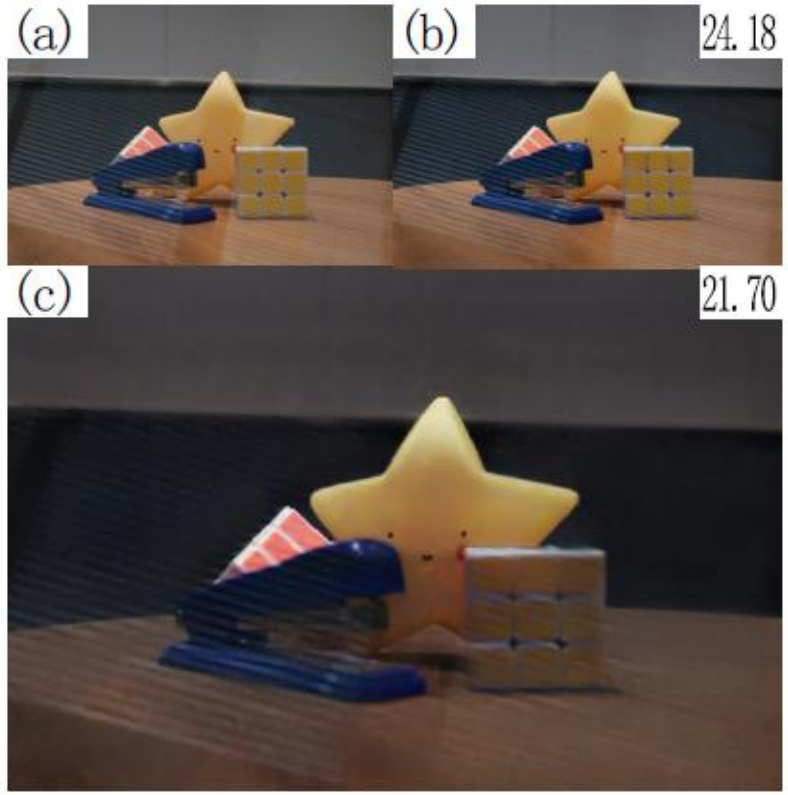
5. More Visual Results



(1) Input/GT

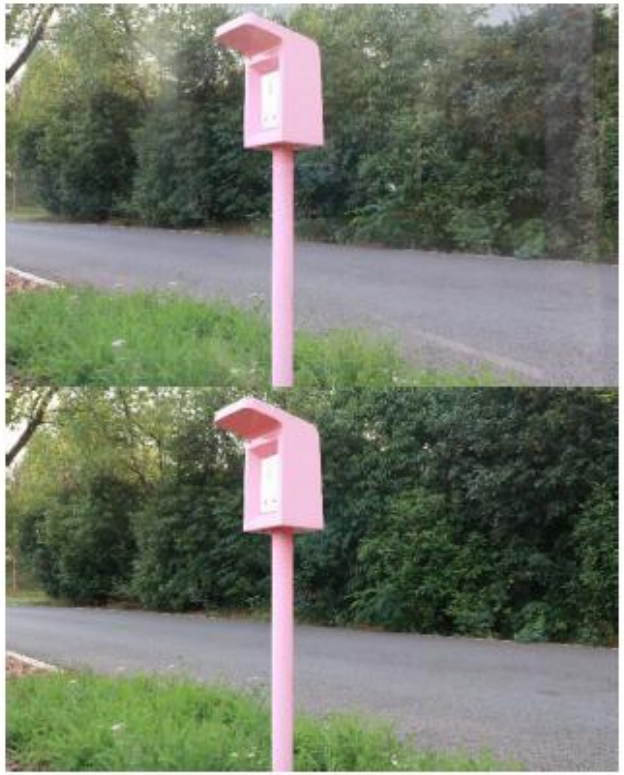


(2) WY19

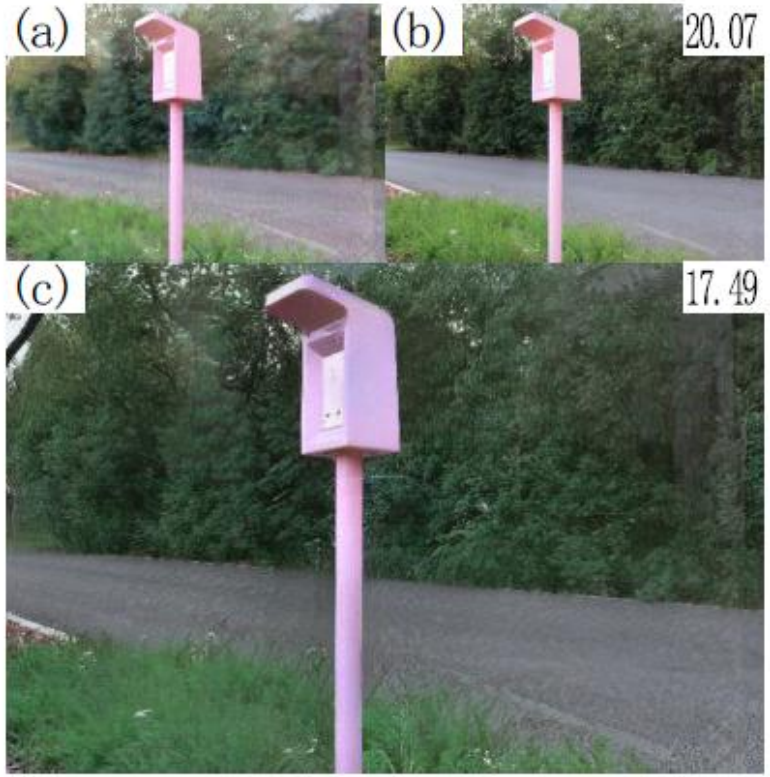


(3) Ours

5. More Visual Results



(1) Input/GT



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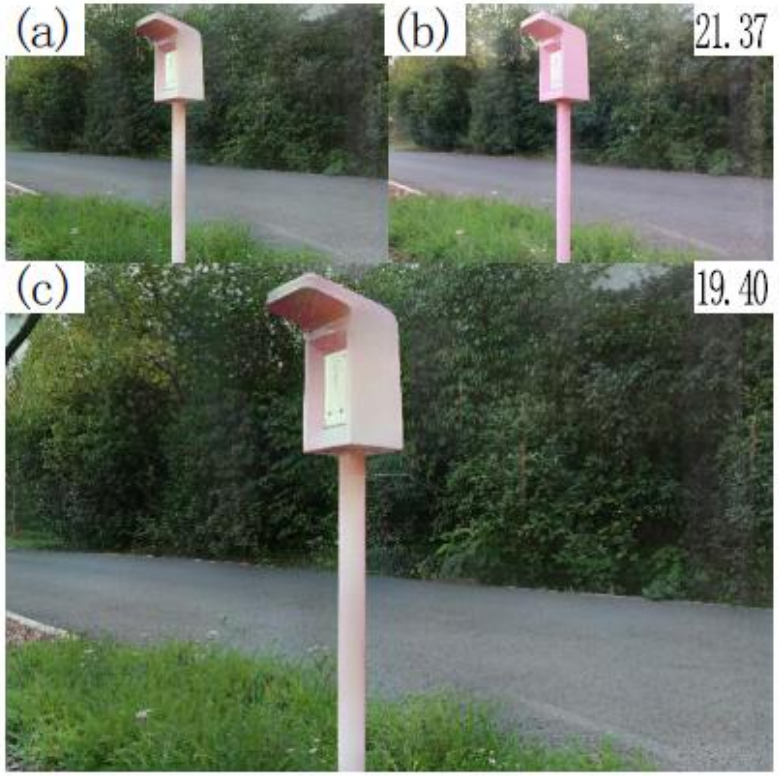
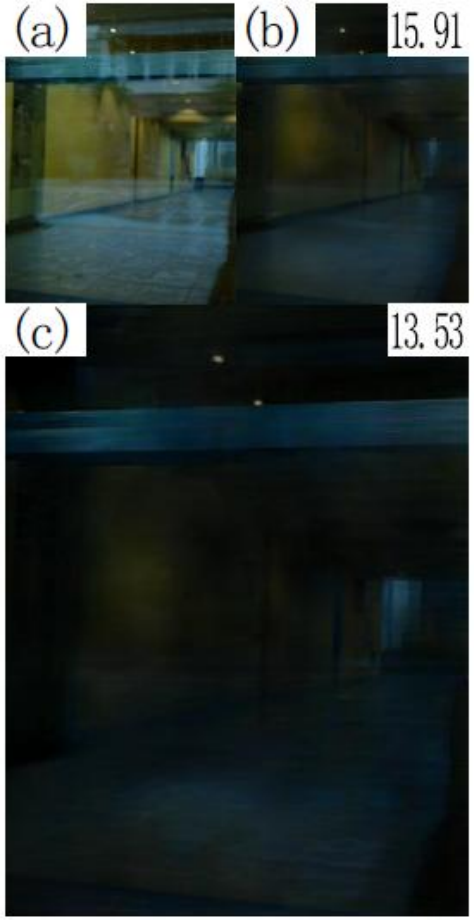


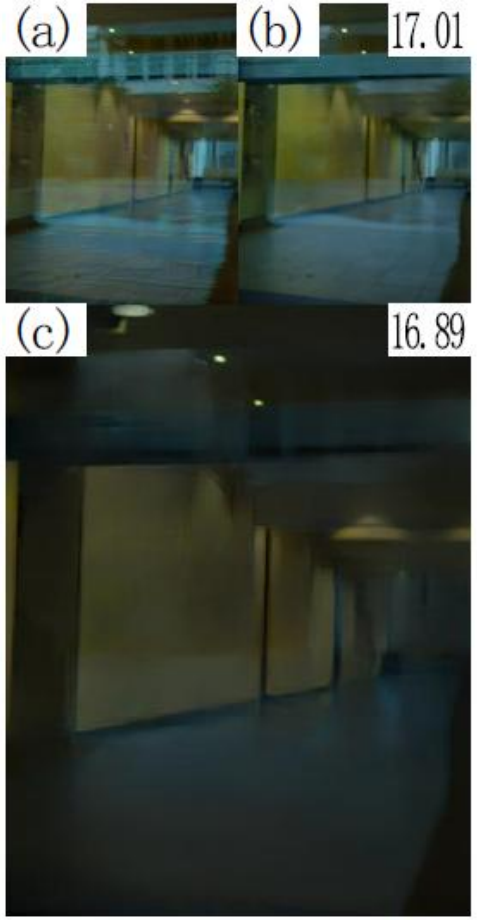
(3) Ours

5. More Visual Results

(1) Input/GT

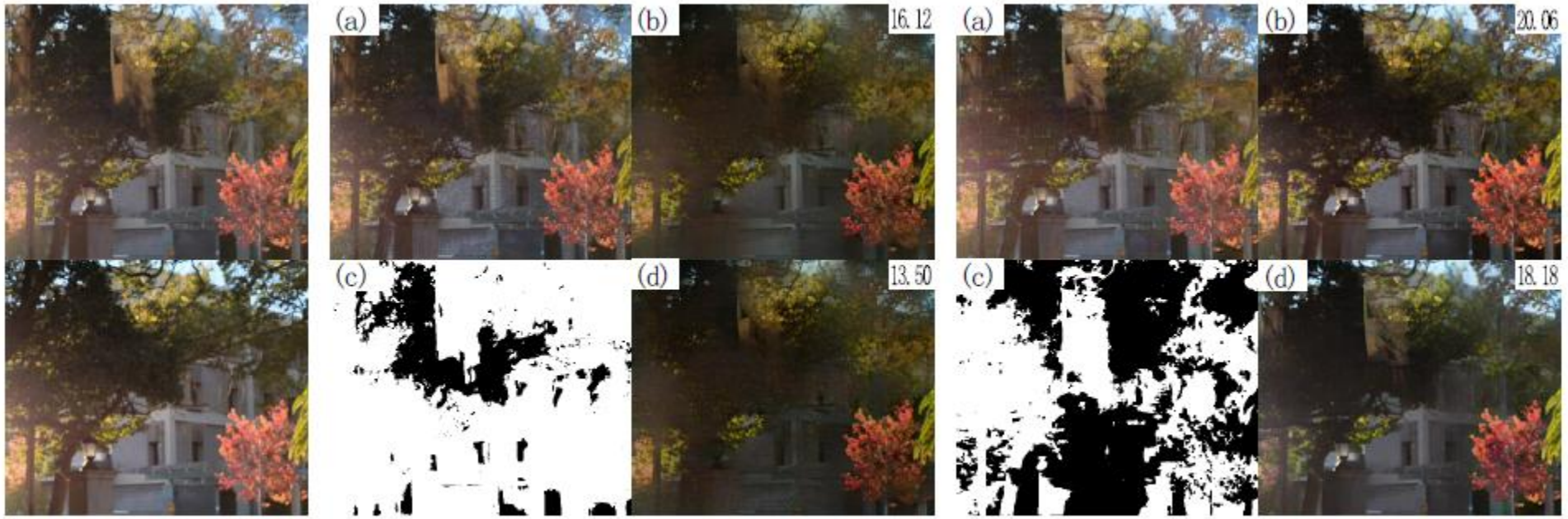


(2) WY19



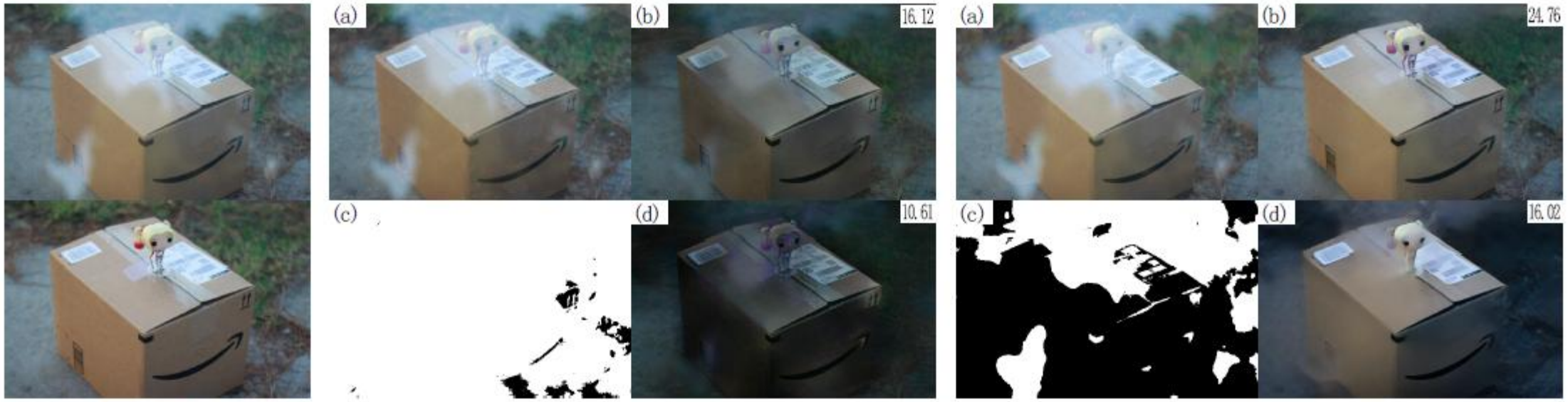
(3) Ours

5. More Visual Results



(1) Input/GT (2) WY19 (3) Ours

5. More Visual Results



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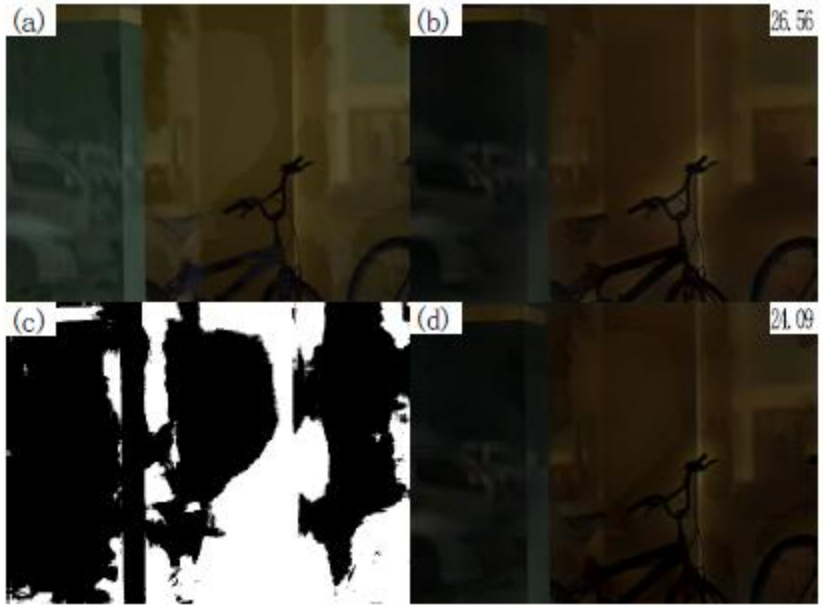
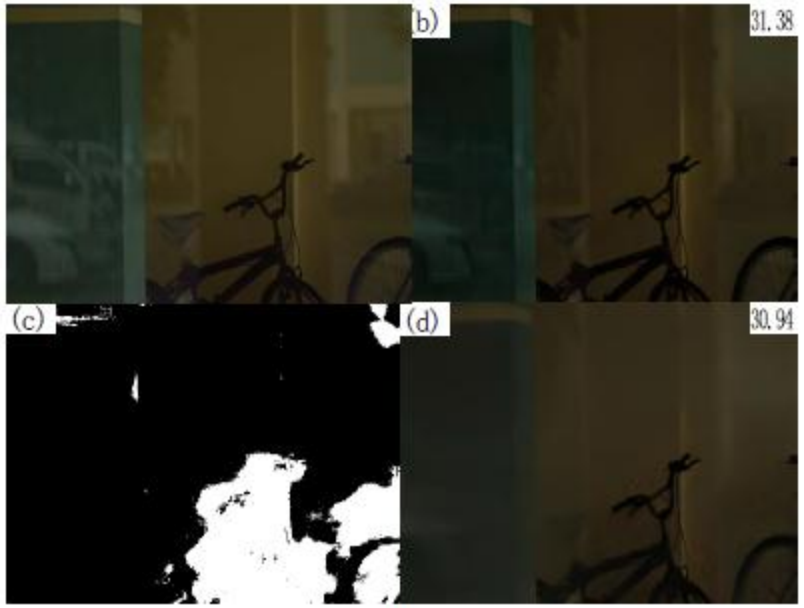
(1) Input/GT



(2) WY19



(3) Ours