Raindrop Clarity: A Dual-Focused Dataset for Day and Night Raindrop Removal

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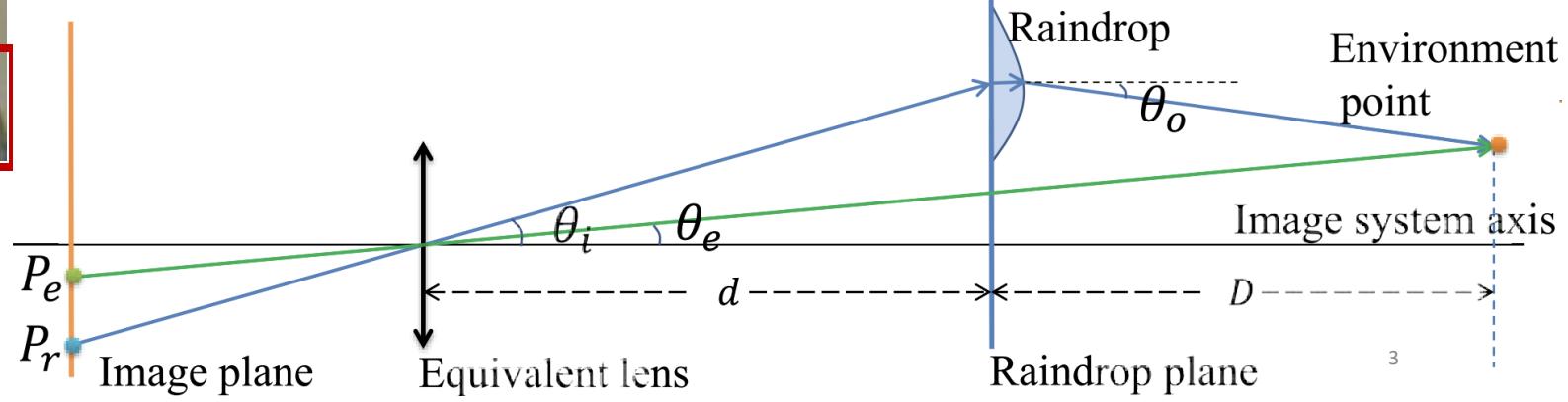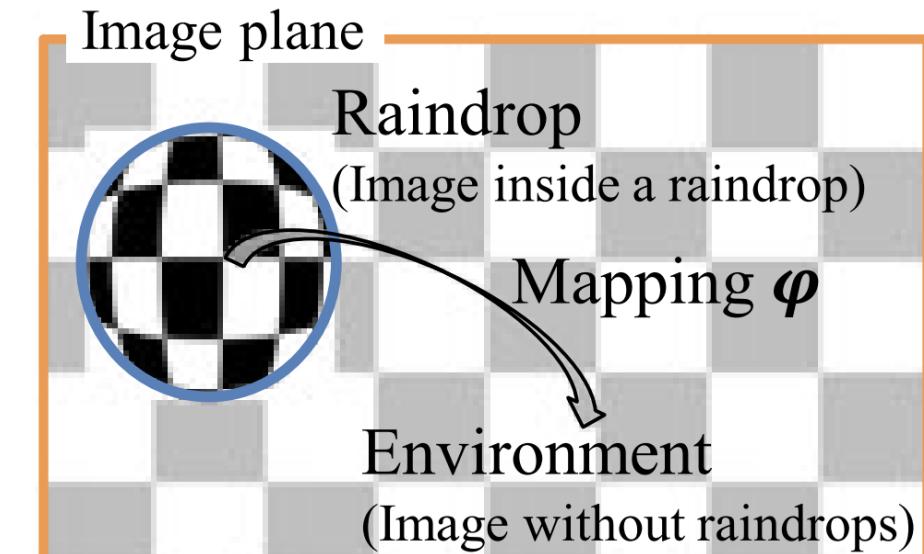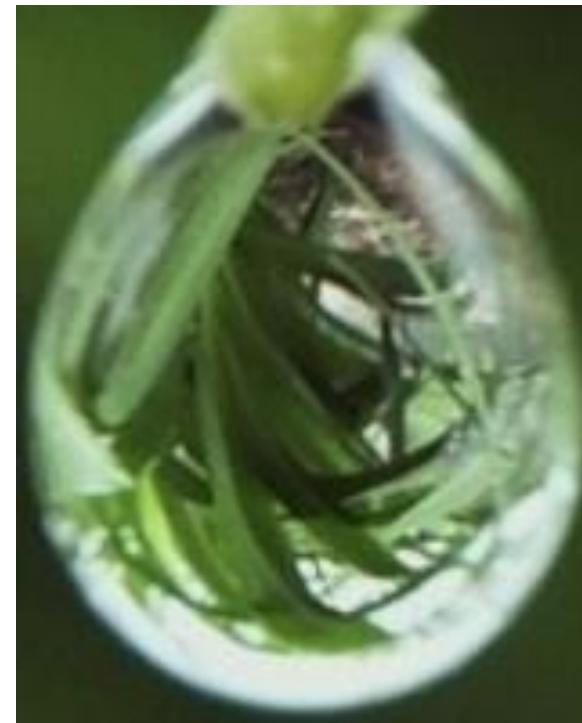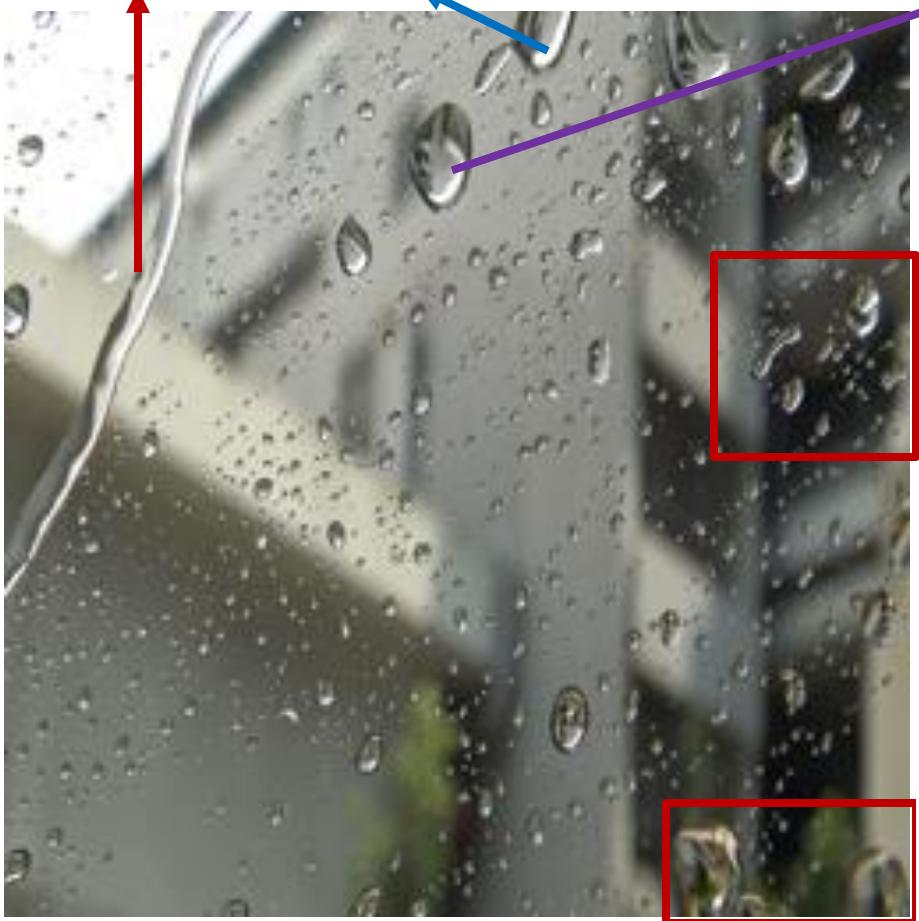
[3]University of Electronic Science and Technology of China

Motivation & Problem

Raindrop

Various Shapes, Glare, Transparency, Blur, Upside-down

Image plane

Raindrop
(Image inside a raindrop)

Mapping φ

Environment
(Image without raindrops)

Raindrop

Environment point

θ_o

θ_i θ_e

Image system axis

P_e

P_r

d

D

Image plane

Equivalent lens

Raindrop plane

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Motivation

➢ Existing raindrop removal datasets:

(a) Qian   (b) RainDS Quan   (c) RobotCar Porav   (d) Windshield

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Main limitations: 1. ❌ raindrop-focused, 2. ❌ night raindrops.

Raindrop Datasets Problems

➤ Raindrop-focused:
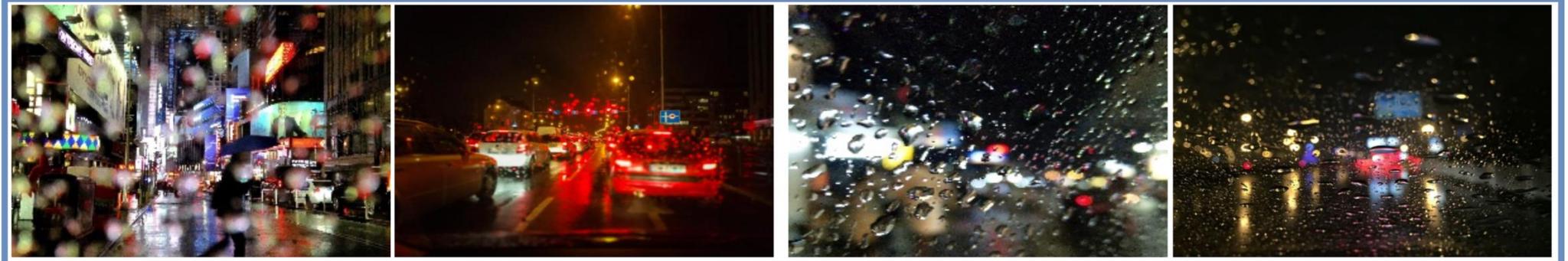
Rd = Raindrop, Bg = Background

➤ Night raindrops:

Main contributions: 1. ✓ raindrop-focused, 2. ✓ night raindrops.

Key Contributions

# Contribution 1: Raindrop-focused

Background-focused (Blurry raindrop)

Day

(a) Background-focused $\tilde{\mathbf{x}}$ (b) Clear Background $\mathbf{b}_0$

Raindrop-focused (Blurry background)

(a) Raindrop-focused $\tilde{\mathbf{x}}$ (b) Blurry background $\mathbf{x}_0$ (c) Clear background $\mathbf{b}_0$

Contribution 2: Night Raindrops

Background-focused (Blurry raindrop)

Night

(a) Background-focused $\tilde{\mathbf{x}}$
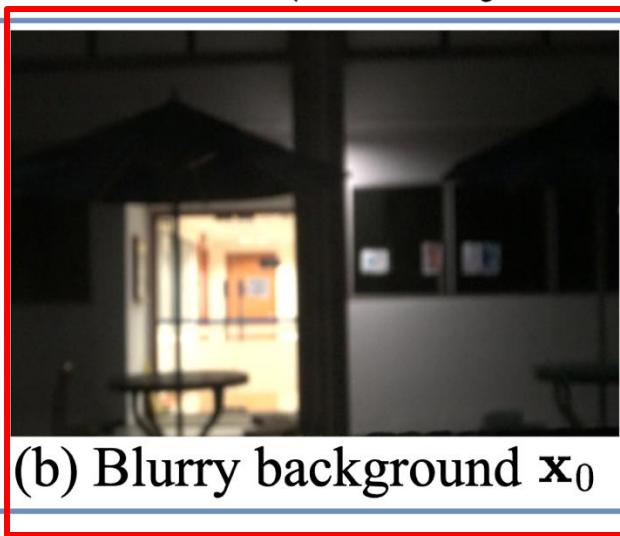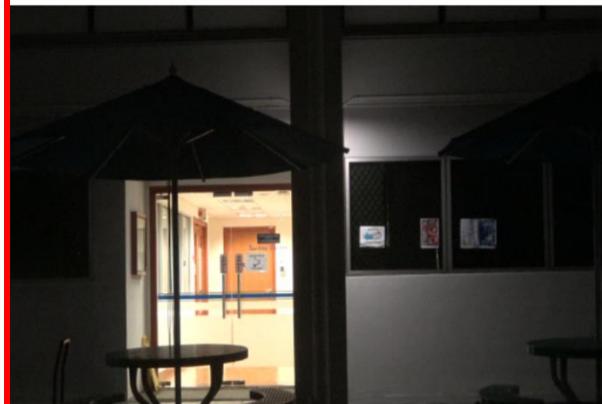
(b) Clear Background $\mathbf{b}_0$

Raindrop-focused (Blurry background)

(a) Raindrop-focused $\tilde{\mathbf{x}}$

(b) Blurry background $\mathbf{x}_0$

(c) Clear background $\mathbf{b}_0$

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Raindrop Clarity

Background-focused (Blurry raindrop)

Raindrop-focused (Blurry background)

Day

(a) Background-focused $\tilde{\mathbf{x}}$

(b) Clear Background $\mathbf{b}_0$

(a) Raindrop-focused $\tilde{\mathbf{x}}$

(b) Blurry background $\mathbf{x}_0$

(c) Clear background $\mathbf{b}_0$

Night

(a) Background-focused $\tilde{\mathbf{x}}$

(b) Clear Background $\mathbf{b}_0$

(a) Raindrop-focused $\tilde{\mathbf{x}}$

(b) Blurry background $\mathbf{x}_0$

(c) Clear background $\mathbf{b}_0$

Raindrop Clarity

Table 1. Summary of comparisons between our Raindrop Clarity and existing datasets. Bg-focus = Background-focused, Rd-focus = Raindrop-focused, RD = Raindrop. Raindrop Clarity uniquely features raindrop-focused triplets and the nighttime raindrops.

Datasets	Components	N. Images	Syn/ Real	Bg-focus Day	Bg-focus Night	Rd-focus Day	Rd-focus Night
Our RD Clarity (Day)	3,606 Triplets+1,836 Pairs	14,490	Real	✓	✗	✓	✗
Our RD Clarity (Night)	4,838 Triplets+4,906 Pairs	24,326	Real	✗	✓	✗	✓
Raindrop Qian [25]	919 Pairs	1,838	Real	✓	✗	✗	✗
RainDS-Real [26]	248 Quadruplets	992	Real	✓	✗	✗	✗
RainDS-Syn [26]	1,200 Quadruplets	4,800	Syn	✓	✗	✗	✗
RobotCar Porav [24]	4,818 Pairs	9,636	Real	✓	✗	✗	✗
Windshield [30]	3,390	3,390	Real	✓	✗	✗	✗

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Characteristics

Background-focused (Blurry raindrop)

(a) Background-focused $\tilde{\mathbf{x}}$

(b) Clear background $\mathbf{b}_0$

various sizes, shapes, and densities

Raindrop-focused (Blurry background)

(a) Raindrop-focused $\tilde{\mathbf{x}}$
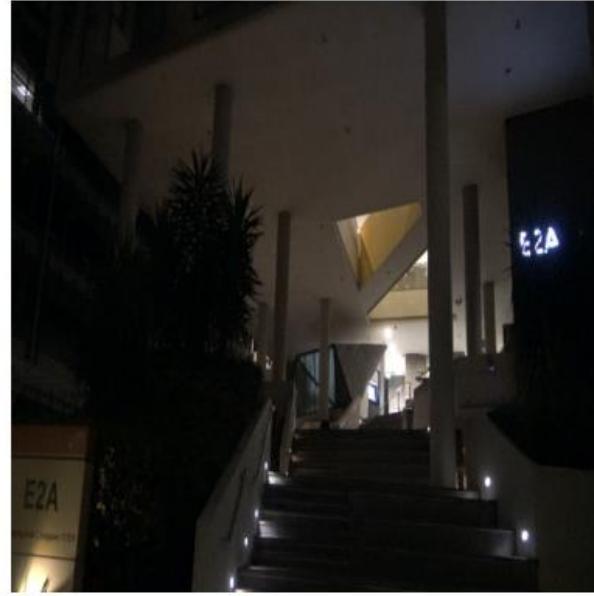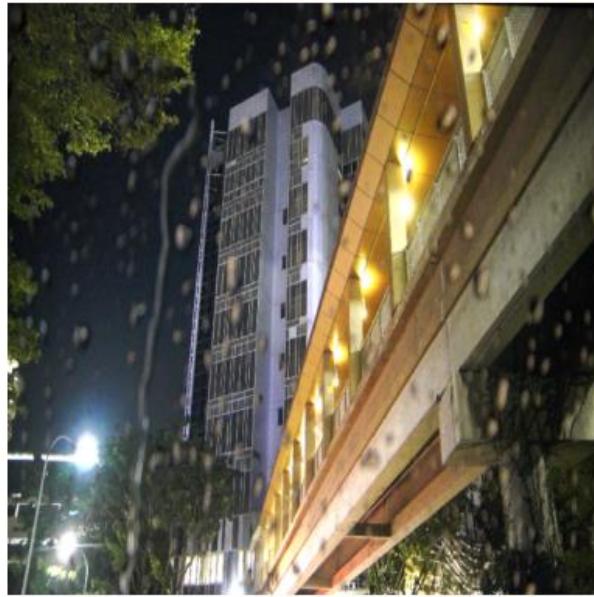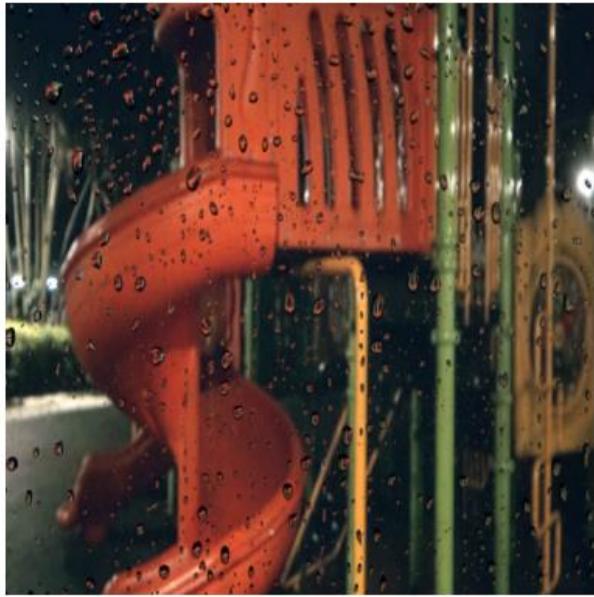
(b) Blurry background $\mathbf{x}_0$

(c) Clear background $\mathbf{b}_0$

diverse scenes and shapes

Background-focused (Blurry raindrop)

(a) Background-focused $\tilde{\mathbf{x}}$

(b) Clear background $\mathbf{b}_0$
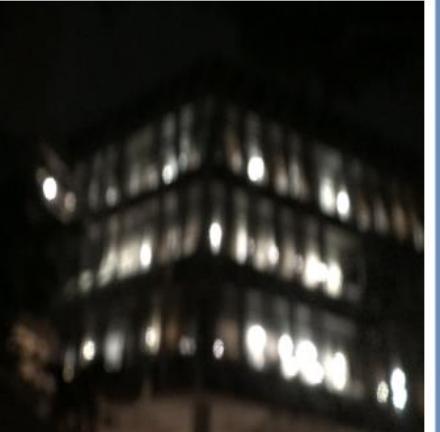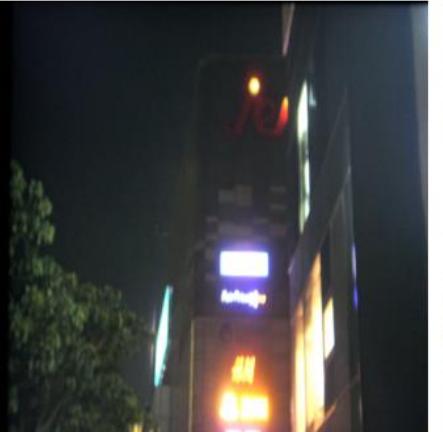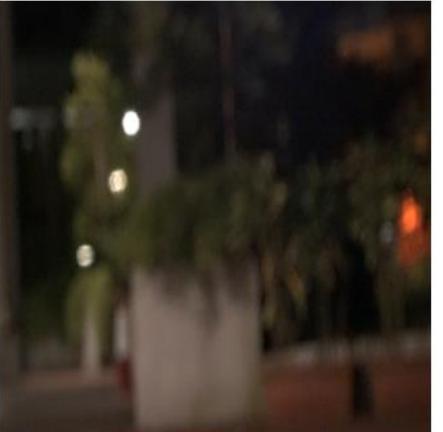
different lighting conditions

Raindrop-focused (Blurry background)
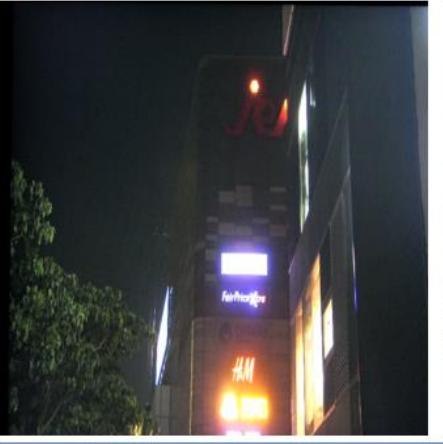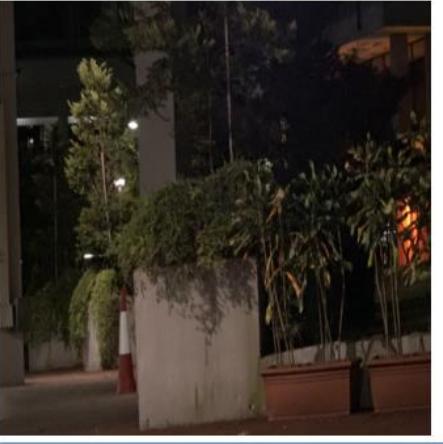
(a) Raindrop-focused $\breve{\mathbf{x}}$
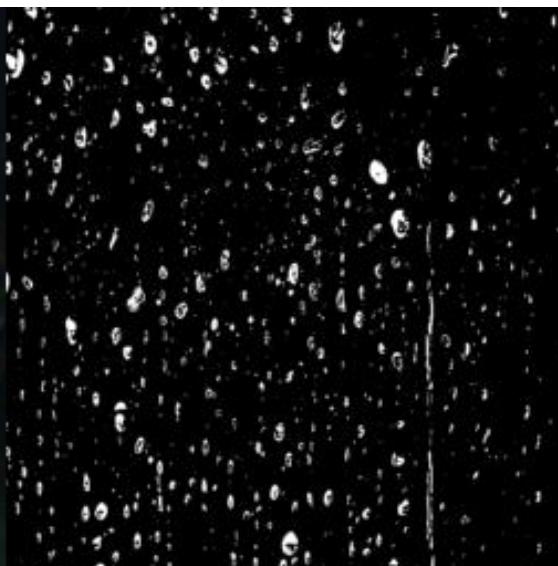
(b) Blurry background $\mathbf{x}_0$

(c) Clear background $\mathbf{b}_0$
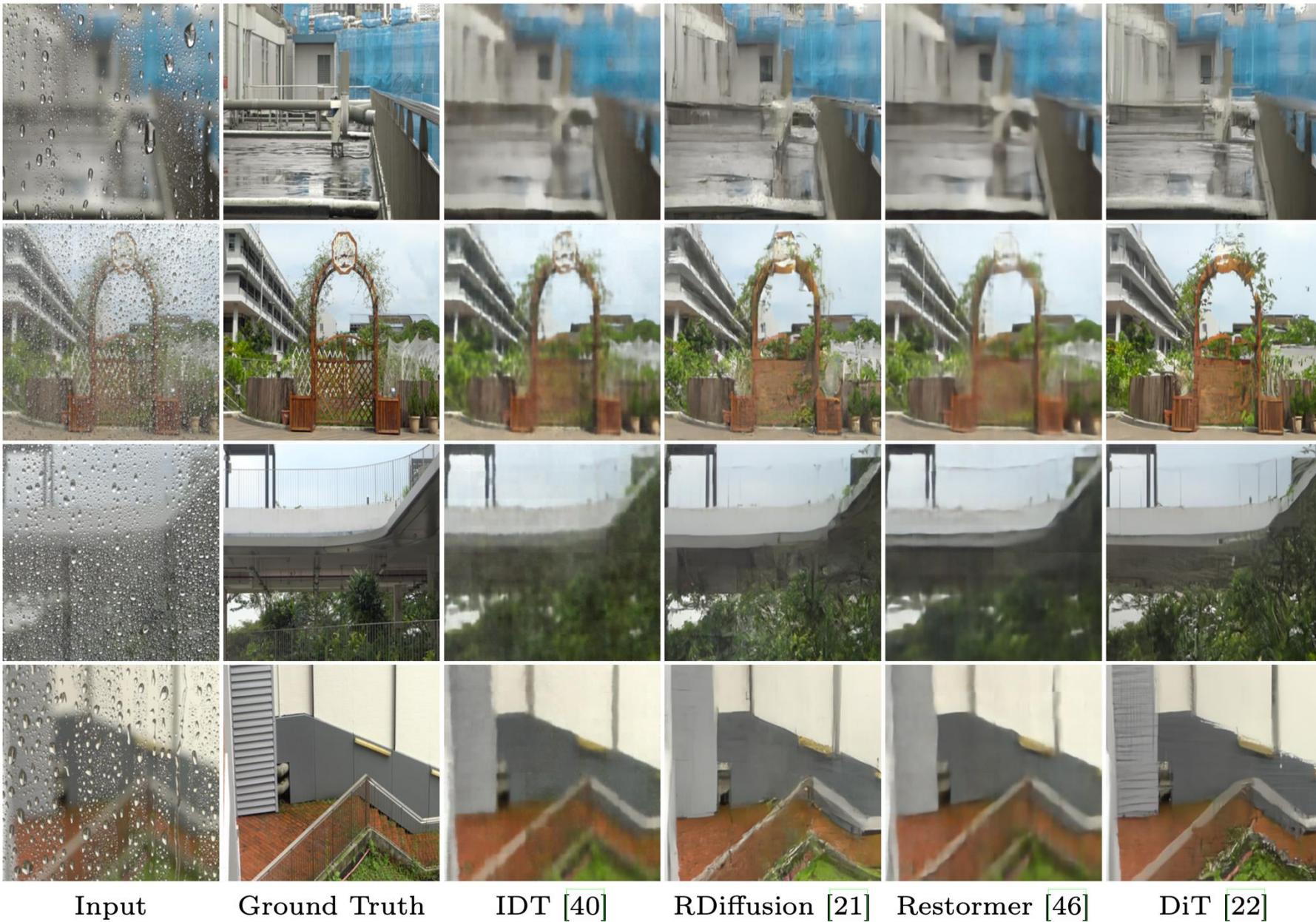
Raindrop Clarity -- Difference Map
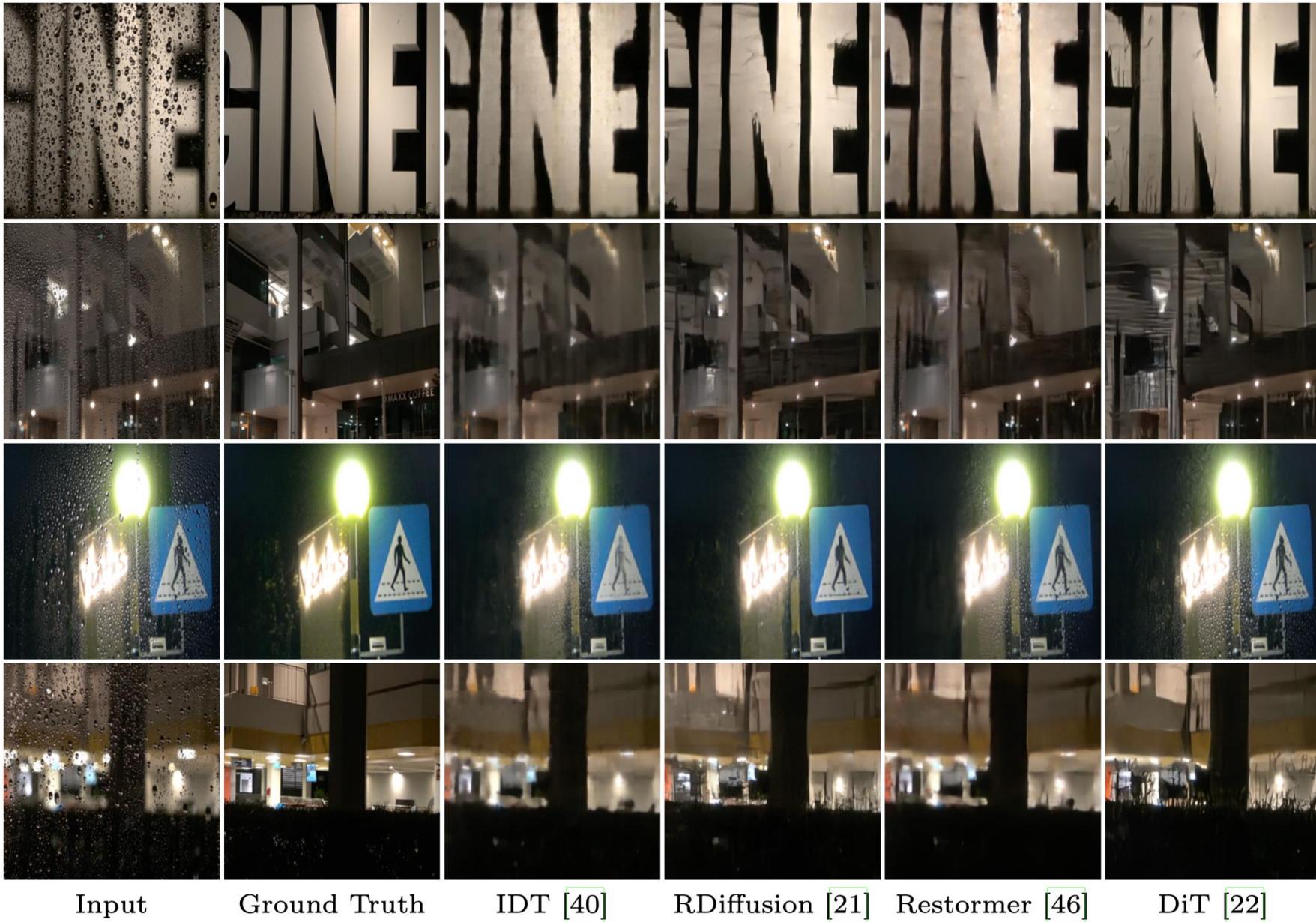
Benchmark Results & Conclusions

Daytime Raindrop-focused

| Input | Ground Truth | IDT [40] | RDiffusion [21] | Restormer [46] | DiT [22] |

Nighttime Raindrop-focused

Input   Ground Truth   IDT [40]   RDiffusion [21]   Restormer [46]   DiT [22]
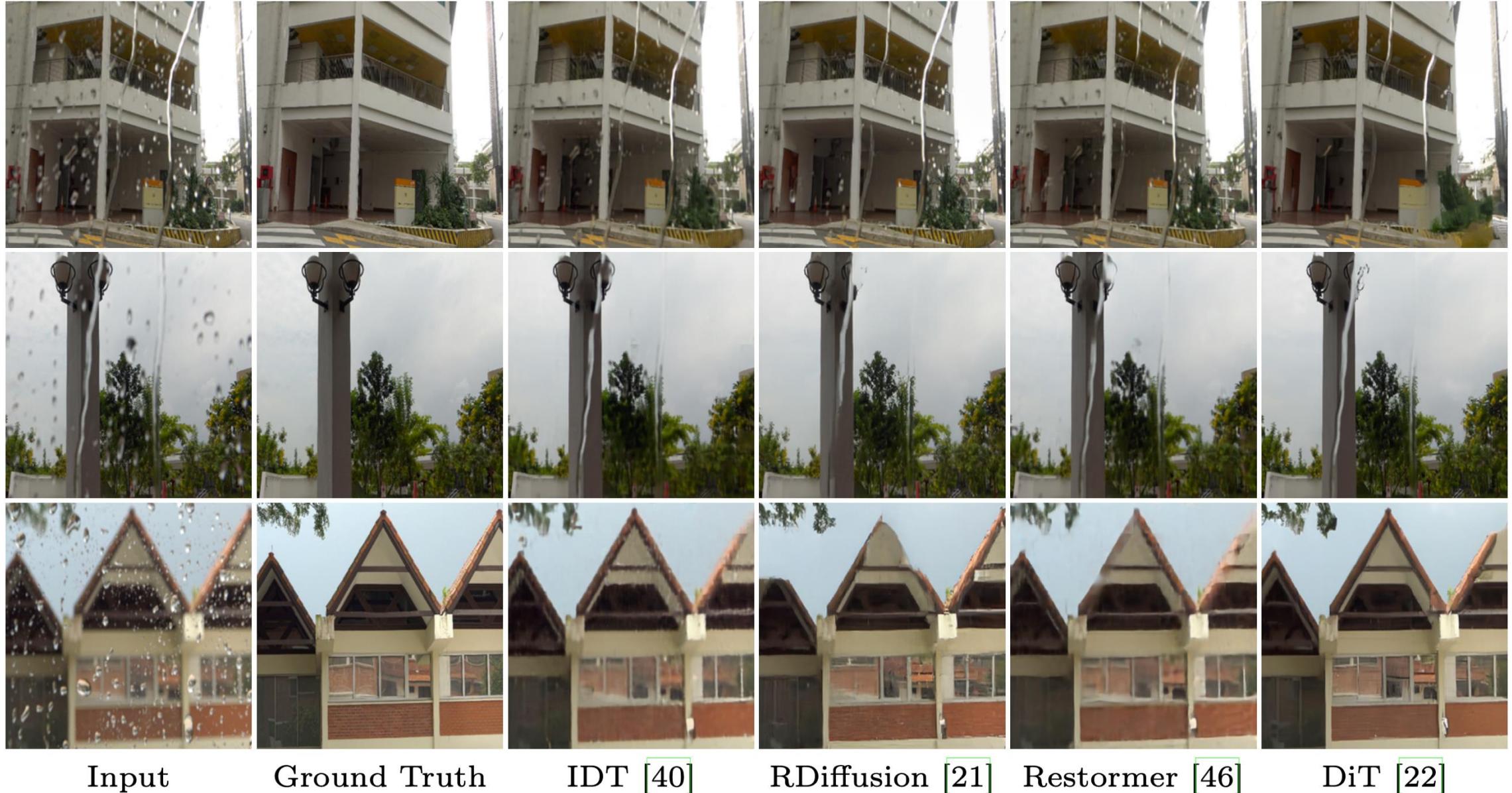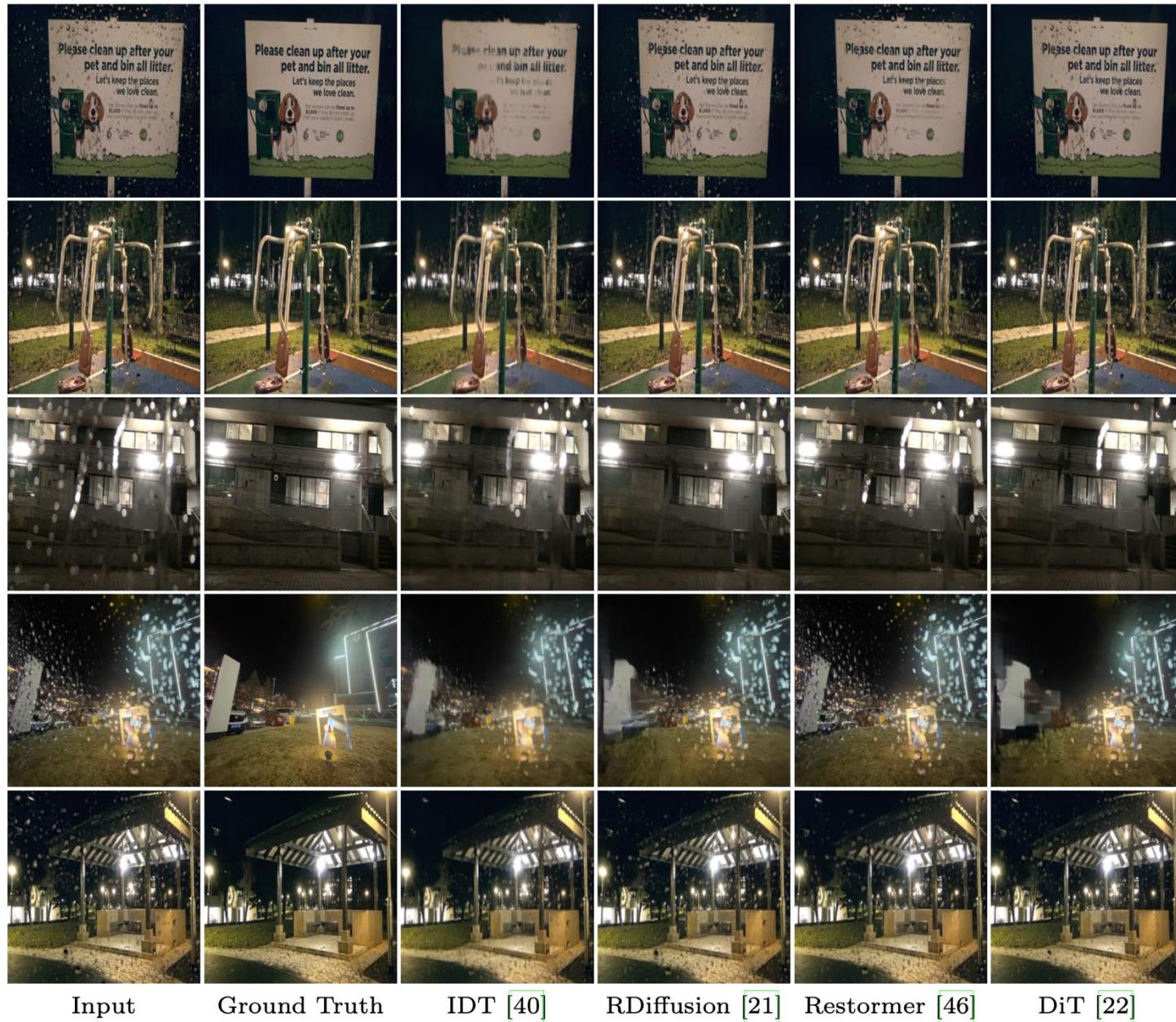
Daytime Background-focused

Input   Ground Truth   IDT [40]   RDiffusion [21]   Restormer [46]   DiT [22]

Input   Ground Truth   IDT [40]   RDiffusion [21]   Restormer [46]   DiT [22]
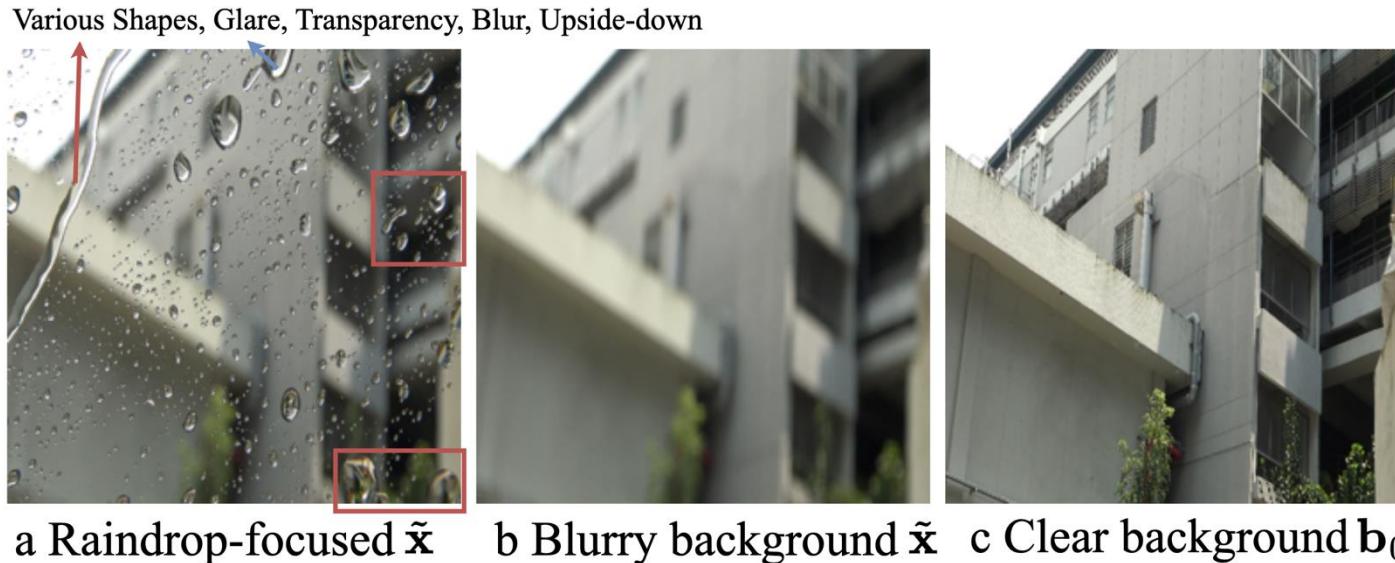
Quantitative Results

Table 2. Quantitative evaluation of daytime and nighttime raindrop data with a benchmark for raindrop algorithms and restoration backbones.

Data\Method	Input	Raindrop Algorithms					Restoration Backbones		
		AtGAN [25]	Robot [24]	RainDS [26]	IDT [40]	RDdiff [21]	Restor. [46]	Uform. [36]	DiT [22]
Day PSNR↑	21.92	23.62	23.82	25.39	26.05	25.52	**26.08**	25.78	26.03
Day SSIM↑	0.560	0.658	0.670	0.717	0.736	0.734	0.748	0.727	**0.752**
Day LPIPS↓	0.247	0.200	0.191	0.147	0.141	0.111	0.131	0.148	**0.106**
Night PSNR↑	24.78	24.38	24.57	25.39	26.81	26.48	**26.87**	25.26	26.23
Night SSIM↑	0.726	0.773	0.787	0.820	**0.851**	0.831	0.848	0.816	0.826
Night LPIPS↓	0.209	0.185	0.182	0.139	0.125	0.112	0.123	0.142	**0.111**

Conclusion

➢ We introduce the Raindrop Clarity dataset, a large real-world dataset that includes both **raindrop-focused triplets** and background-focused pairs.

➢ Raindrop Clarity includes images collected during both day and **night**.

➢ Our benchmark results indicate that state-of-the-art methods struggle to perform effectively in **raindrop-focused** or **night** scenarios.

Various Shapes, Glare, Transparency, Blur, Upside-down

a Raindrop-focused $\tilde{x}$ b Blurry background $\tilde{x}$ c Clear background b_0

Thank you!

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CODES AND MODEL:

HTTPS://GITHUB.COM/JINYEYING/RAINDROPCLARITY