SynFog: A Photo-realistic Synthetic Fog Dataset based on End-to-end Imaging Simulation for Advancing Real-World Defogging in Autonomous Driving

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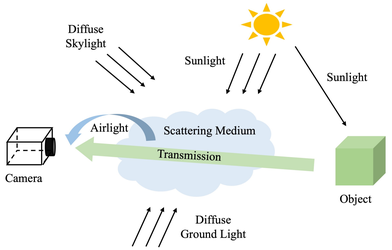
CVPR SEATTLE, WA JUNE 17-21, 2024

Motivations



Contributions

End-to-end foggy image simulation pipeline:

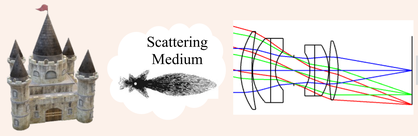
- accurate light transportation in scattering medium
- physical characteristics of optics and sensor

SynFog dataset:

- both skylight and active lighting conditions
- three levels of fog density
- pixel-accurate depth data and segmentation labels

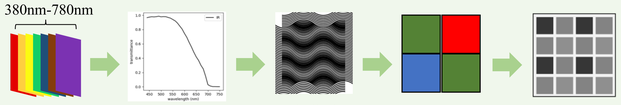
End-to-end Foggy Image Simulation Pipeline

Rendering & Optics Module

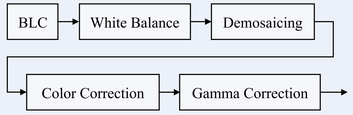


Physically-based Volumetric Path Tracing

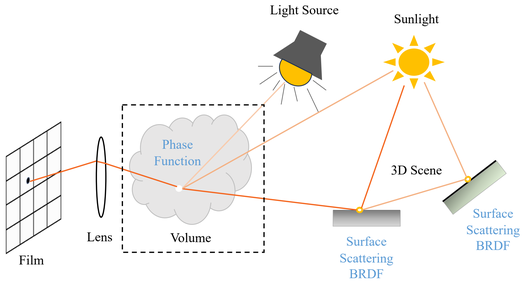
Sensor Module



ISP Module

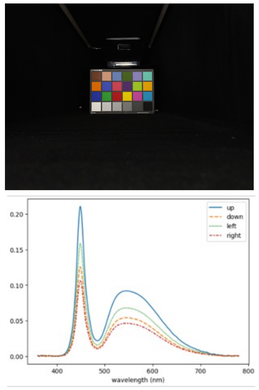


Foggy Scene Rendering

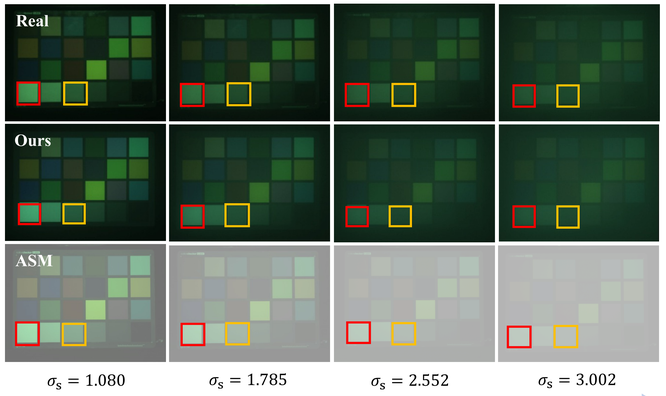


$$p_{\mathrm{HG}}(\cos\theta) = \frac{1}{4\pi}\frac{1-g^2}{(1+g^2+2g(\cos\theta))^{3/2}}$$

Validation



Foggy images are brightened for better visualization.



Transferability across the Real-to-Virtual Gap

Training Set	O-Haze [2]			Foggy Zurich [11]	Foggy Driving [40]	BeDDE [56]
	PSNR ↑	SSIM ↑	DHQI [14] ↑	DHQI [14] ↑	DHQI [14] ↑	DHQI [14] ↑
Foggy Cityscapes	14.46	0.5737	43.40	52.06	51.55	36.07
Virtual KITTI	13.90	0.5315	42.80	50.94	47.46	33.42
SynFog	**15.43**	**0.6116**	**44.46**	**54.16**	**52.07**	**43.28**

Method	Training Set	FZ [11]	STF [5]
		mAP (%)	mAP (%)
AECRNet	Foggy Cityscapes	69.7	54.8
	Virtual KITTI	68.9	53.3
	SynFog	**71.5**	**55.5**
DehazeFormer	Foggy Cityscapes	67.9	54.9
	Virtual KITTI	68.5	53.1
	SynFog-β	59.7	**55.3**
	SynFog	**69.7**	**55.3**

Experimental setting	FZ [11]	STF [5]
	mAP (%)	mAP (%)
AECRNet+SynFog(w/o noise)	69.5	54.7
AECRNet+SynFog(w/ noise)	**71.5**	**55.5**

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