

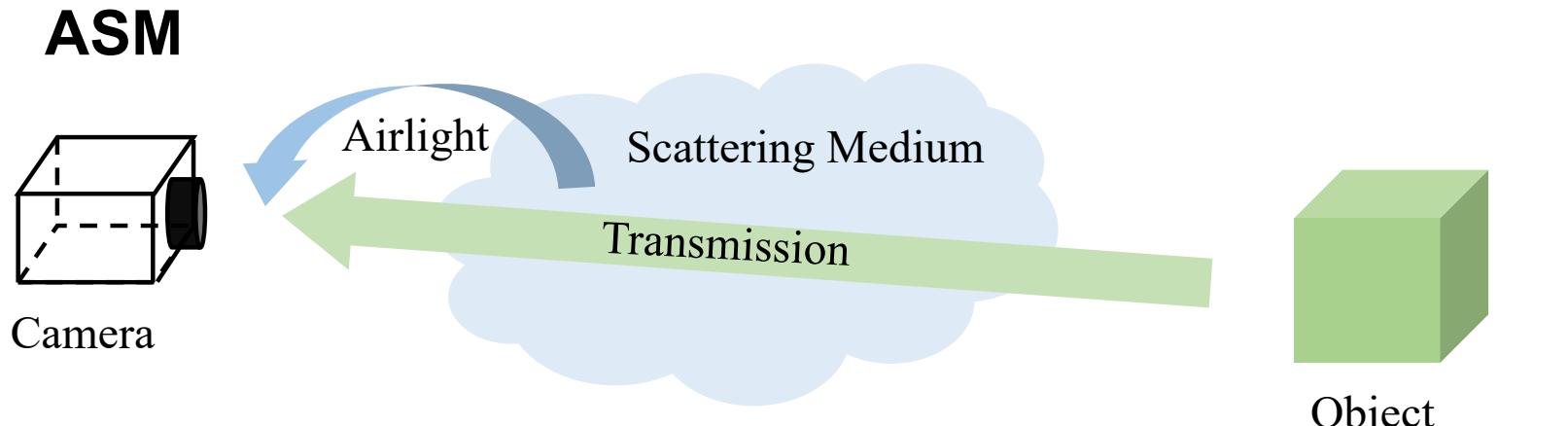
SynFog: A Photo-realistic Synthetic Fog Dataset based on End-to-end Imaging Simulation for Advancing Real-World Defogging in Autonomous Driving

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Motivations



- fail to consider accurate global illumination and the actual imaging process
- disparity between synthetic and real-world foggy images, limited robustness

Contributions

End-to-end foggy image simulation pipeline:

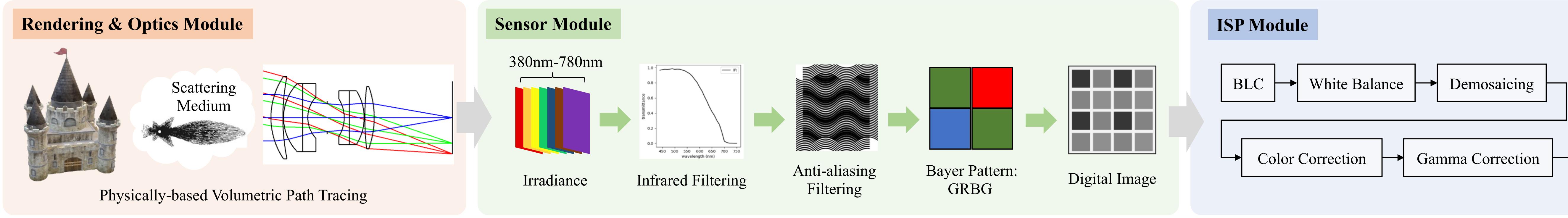
- accurate light transportation in scattering medium
- physical characteristics of optics and sensor

SynFog dataset:

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

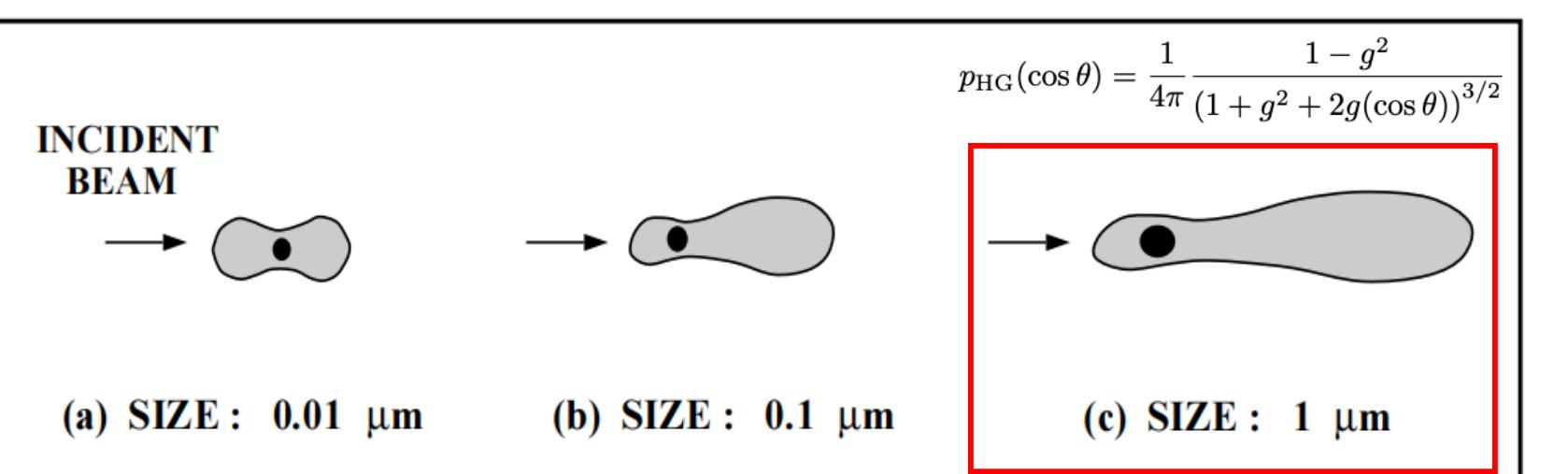


End-to-end Foggy Image Simulation Pipeline

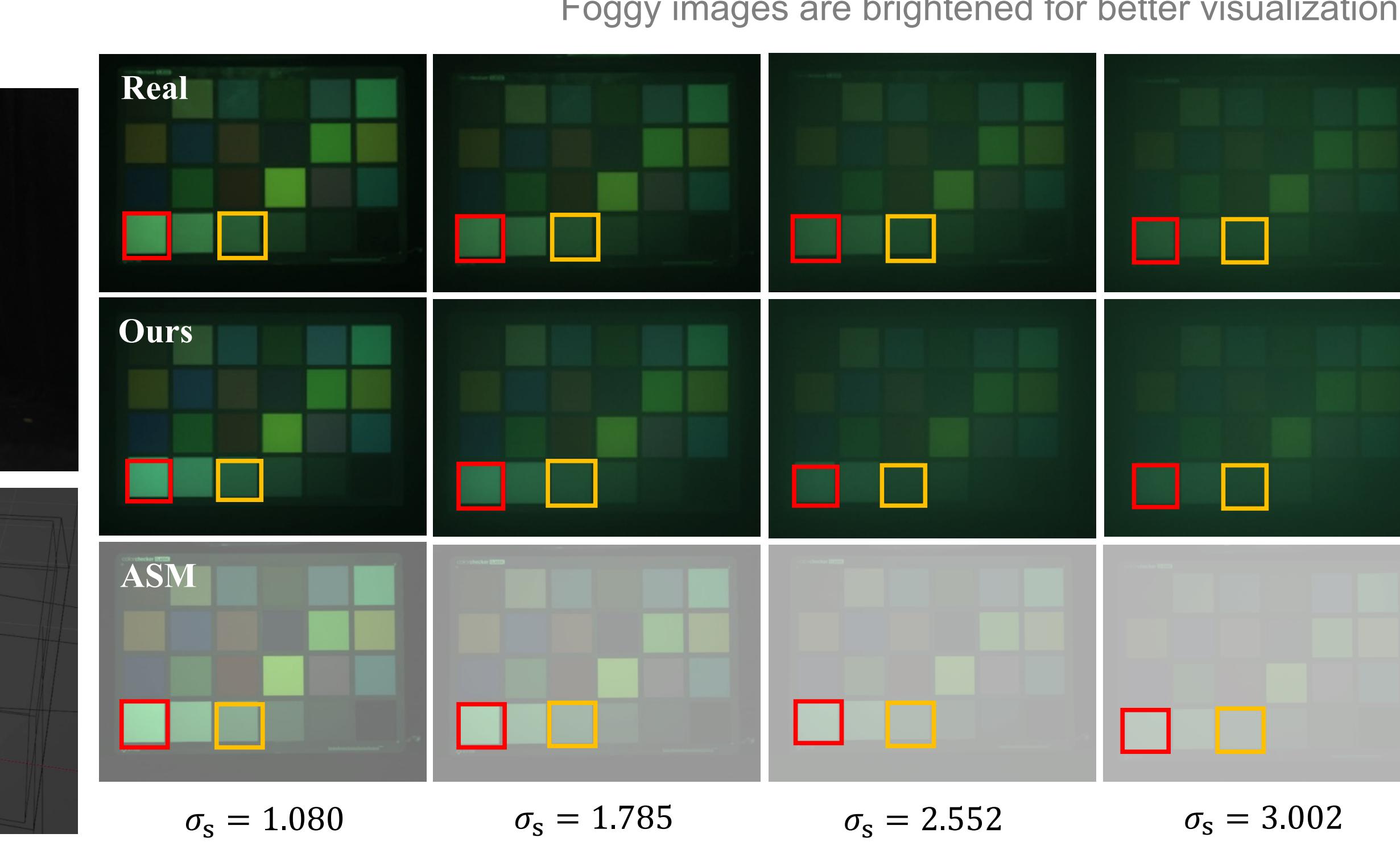


Foggy Scene Rendering

CONDITION	PARTICLE TYPE	RADIUS (μm)	CONCENTRATION (cm^{-3})
AIR	Molecule	10^{-4}	10^{19}
HAZE	Aerosol	$10^{-2} - 1$	$10^3 - 10$
FOG	Water Droplet	1 - 10	100 - 10
CLOUD	Water Droplet	1 - 10	300 - 10
RAIN	Water Drop	$10^2 - 10^4$	$10^{-2} - 10^{-5}$



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]	Experimental setting	FZ [11]	STF [5]
		mAP (%)	mAP (%)		mAP (%)	mAP (%)
AECRNet	Foggy Cityscapes	69.7	54.8	AECRNet+SynFog(w/o noise)	69.5	54.7
	Virtual KITTI	68.9	53.3		71.5	55.5
	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			



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