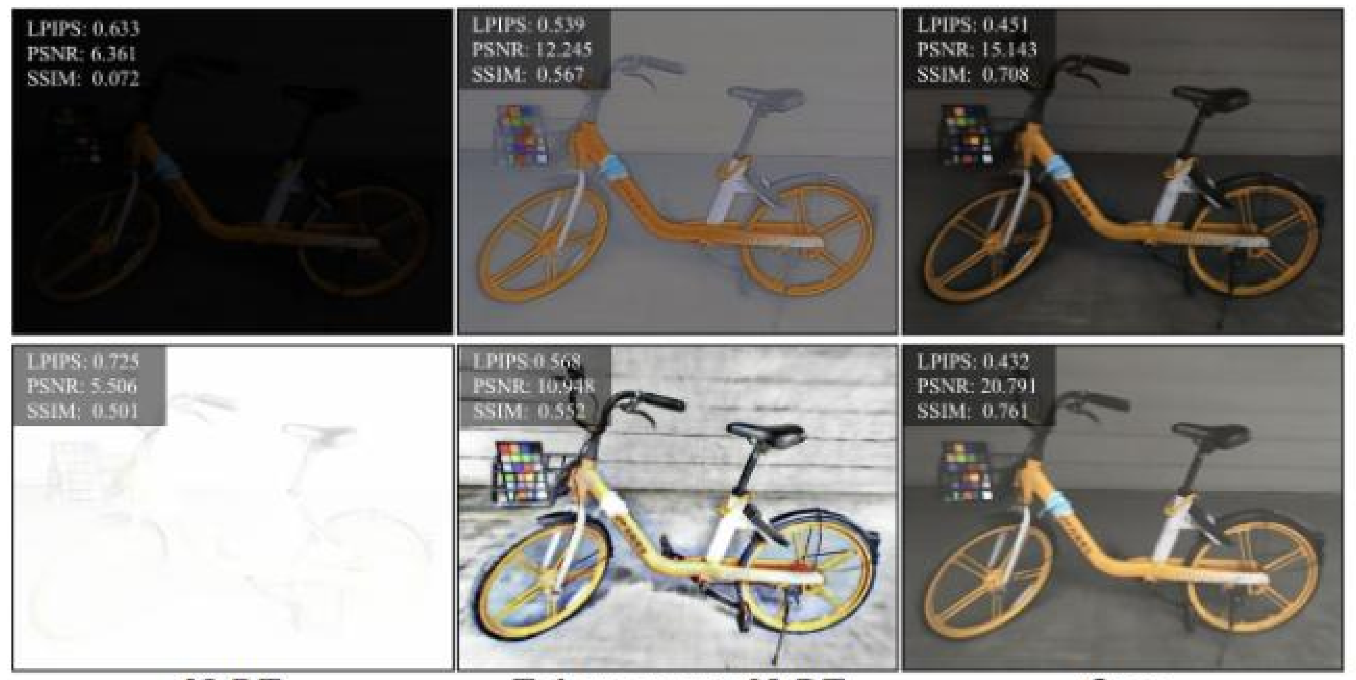
ADAPTIVE MULTI-EXPOSURE FUSION FOR ENHANCED NEURAL RADIANCE FIELDS

Yang Zou, Xingyuan Li, Zhiying Jiang, Tiantian Yan, Jinyuan Liu
Dalian University of Technology, China

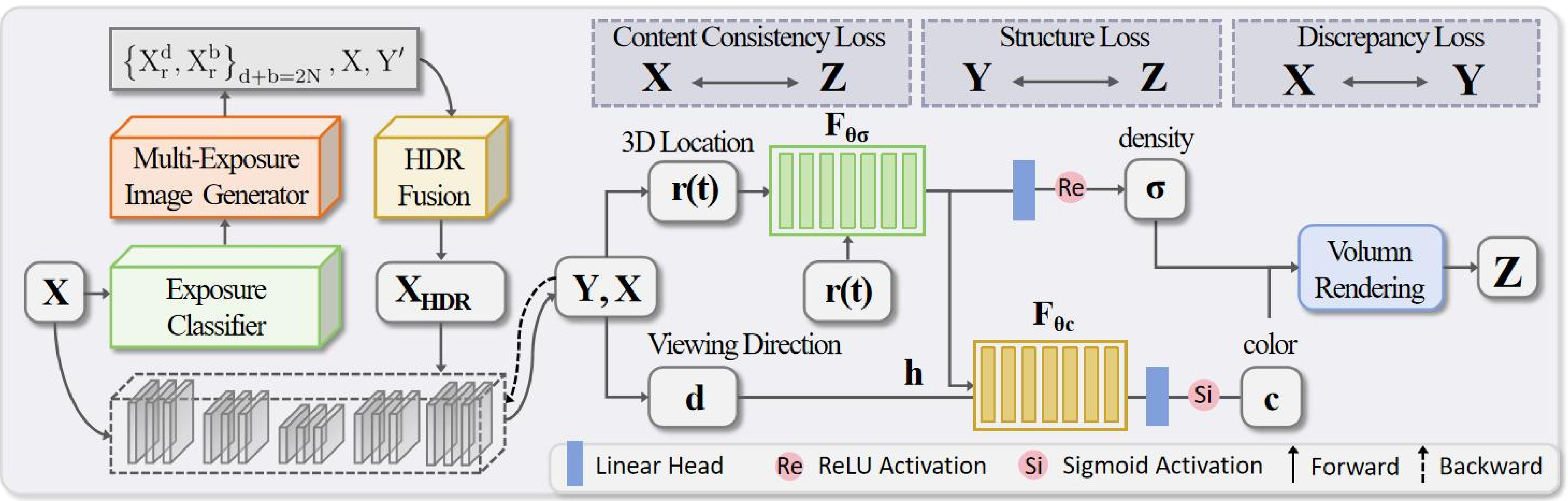
Contributions



- Our approach's architecture efficiently addresses multi- exposure challenges in Neural Radiance Fields (NeRF) through a twofold approach. At its core, the exposure classifier assesses input image exposure levels by analyzing histogram peaks and skewness, dynamically determining gamma correction values for brightness normalization.
- The Muti-Exposure Image Generayor then employs these values, applying a gamma mapping function to harmonize exposures across varying images, facilitating effective HDR fusion. Overall, the system architecture enables a seamless integration of multi-exposure correction into the NeRF pipeline, enhancing the model's ability to synthesize novel views under diverse lighting conditions without compromising on the quality of the rendered scene.

Method

Framework



Exposure Classifier

$$H(i)=\sum[\mathrm{gray}(x,y)=i] \quad \text{for } i\in[0,255]$$

$$P=\operatorname{argmax} H(i),$$

$$S=\frac{1}{N}\sum\left[\frac{(i-\mu)^3}{\sigma^3}\right]$$

Multi-Exposure Image Generator

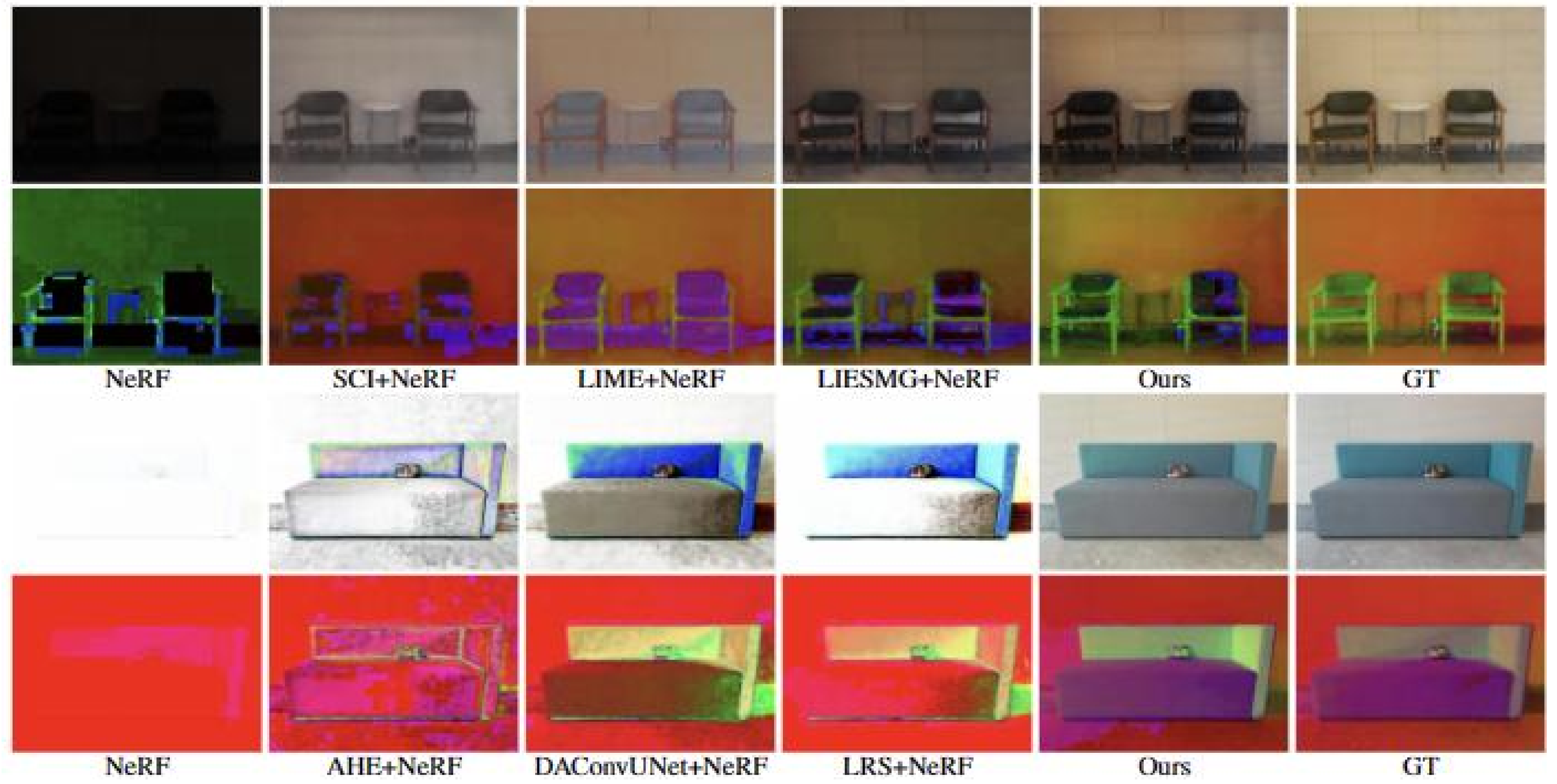
$$\gamma=\frac{1+e^{-(b\cdot P+c\cdot S+d)}}{a}.$$

$$M(\mathbf{X},\gamma)=\mathbf{X}^{\gamma}$$

Experiments

- Quantitative and Qualitative Comparisons: comparison of the latest methods. Our method achieves significant performance improvements across different weather conditions.

Data	Method	"bike"			"buu"			"chair"			"shrub"			"sofa"			mean		
		PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS	PSNR	SSIM	LPIPS
Low Exposure	NeRF	6.36	0.072	0.633	7.51	0.292	0.443	6.04	0.147	0.603	8.01	0.028	0.716	6.27	0.209	0.557	6.84	0.150	0.590
	HE + NeRF	15.29	0.693	0.441	15.52	0.781	0.517	15.41	0.747	0.554	14.74	0.441	0.567	**17.87**	0.811	0.508	15.77	0.695	0.517
	IAT + NeRF	13.49	0.607	0.541	14.49	0.705	0.401	**18.79**	**0.781**	0.671	13.81	0.286	0.565	17.61	0.829	0.545	15.64	0.642	0.545
	LIESMG + NeRF	18.02	0.708	0.479	16.21	0.781	0.392	16.86	0.759	0.526	14.83	0.281	**0.517**	16.81	0.808	0.565	16.55	0.667	0.496
	LIME + NeRF	11.31	0.572	0.471	13.91	0.786	0.316	11.27	0.677	0.533	13.88	0.357	0.521	12.21	0.755	0.445	12.51	0.629	0.457
	SCI + NeRF	13.56	0.651	0.459	7.78	0.693	0.528	11.71	0.741	0.595	**17.63**	0.441	0.523	10.08	0.765	0.518	12.15	0.658	0.525
	Ours	**18.04**	**0.719**	**0.439**	**18.72**	**0.812**	**0.314**	16.92	0.733	**0.422**	15.07	**0.453**	0.529	17.78	**0.832**	**0.416**	**17.22**	**0.708**	**0.413**
High Exposure	NeRF	5.61	0.501	0.725	5.54	0.603	0.715	6.11	0.592	0.713	4.14	0.092	0.753	6.26	0.673	0.694	5.53	0.492	0.720
	DAConvUNet + NeRF	12.62	0.641	0.449	12.59	0.606	0.611	13.23	0.627	0.607	11.31	0.399	0.601	13.27	0.714	0.587	12.60	0.597	0.571
	LRS + NeRF	8.44	0.573	0.541	7.67	0.654	0.655	8.82	0.659	0.651	6.03	0.211	0.714	8.45	0.667	0.621	7.88	0.553	0.636
	CLAHE + NeRF	7.41	0.573	0.596	7.64	0.662	0.592	8.37	0.652	0.602	8.42	0.287	0.616	7.71	0.711	0.634	7.91	0.577	0.608
	AHE + NeRF	10.94	0.552	0.468	9.69	0.395	0.674	11.77	0.499	0.606	11.21	0.399	0.604	9.76	0.603	0.605	10.67	0.490	0.591
	Ours	**20.79**	**0.761**	**0.432**	**17.29**	**0.865**	**0.304**	**24.88**	**0.846**	**0.376**	**16.87**	**0.404**	**0.534**	**23.72**	**0.894**	**0.395**	**20.71**	**0.754**	**0.408**



- Ablation study for the components of our method.