Casual Indoor HDR Radiance Capture from Omnidirectional Images

Pulkit Gera[1], Mohammad Reza Karimi Dastjerdi[2], Charles Renaud[2], P.J Narayanan[1], Jean-François Lalonde[2]
[1] IIIT Hyderabad,India [2]Université Laval,Canada

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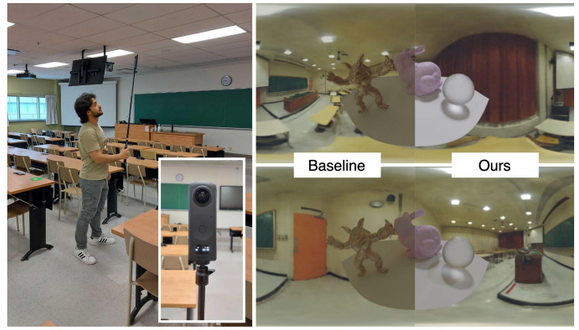
INTRODUCTION

- Capturing radiance of a scene crucial for AR/VR apps
- Need special equipment to capture HDR images and takes lot of time
- Predict HDR light probes at novel locations from casually captured LDR panoramas.



2-min casual capture

HDR radiance at novel views

PREPROCESS

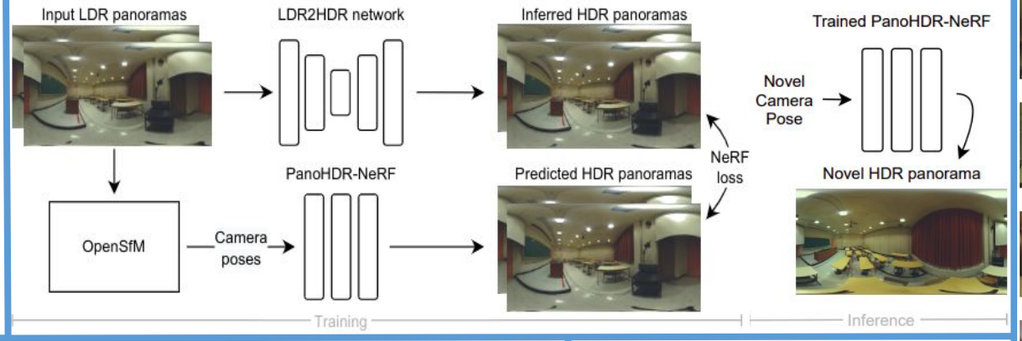
- Capture LDR panoramas using Rico ThetaZ
- Generate masks and remove subject
- Estimate camera poses using OpenSFM

TRAIN

- Estimate HDR panoramas using LDR2HDR module
- Train PanoHDR-NeRF module to predict HDR panoramas at novel viewpoints

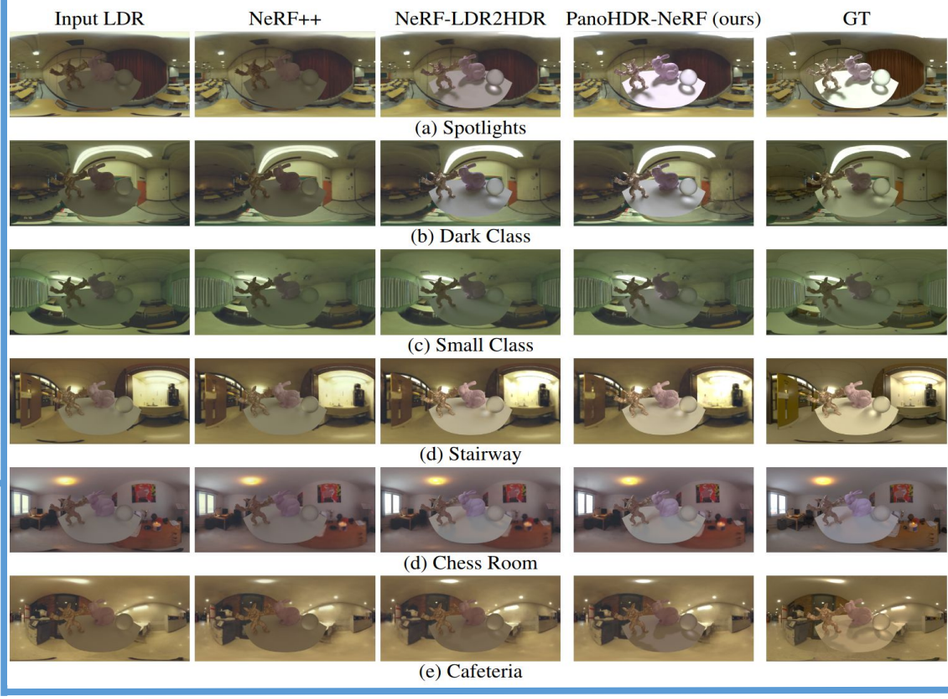
INFER

- For a novel camera viewpoint, infer HDR lightprobes



RESULTS - Virtual Test Object Relit Shows Dynamic Range

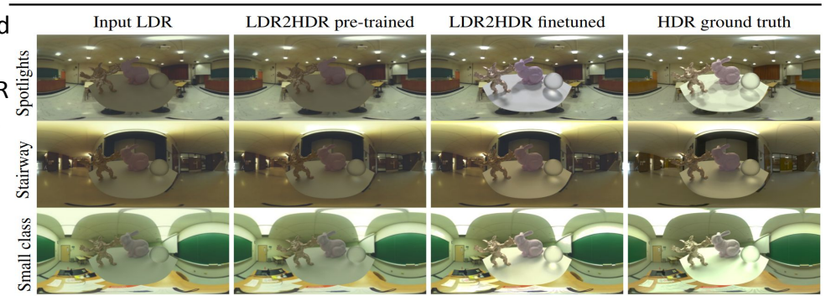
- Comparison with other baselines and methods.
- NeRF++ cant predict HDR Radiance. NeRF-LDR2HDR has flickering artifacts.



LDR2HDR MODULE

- LANet architecture trained on Laval Indoor Dataset
- Domain Gap cause diff. sensor for train and captured data
- Finetuned on 78 HDR captured panoramas
- Relight a small scene with HDR lightprobes and take MSE loss on rendered image

Dataset	Input LDR PU-PSNR↑	Input LDR RMSE↓	Input LDR HDR-VDP3↑	LDR2HDR pre-trained PU-PSNR↑	LDR2HDR pre-trained RMSE↓	LDR2HDR pre-trained HDR-VDP3↑	LDR2HDR finetuned PU-PSNR↑	LDR2HDR finetuned RMSE↓	LDR2HDR finetuned HDR-VDP3↑
Chess room	31.659	0.051	8.067	33.994	0.048	8.234	36.995	0.005	8.492
Stairway	31.964	0.224	7.881	33.297	0.213	8.016	33.685	0.019	8.489
Cafeteria	25.299	5.378	6.098	26.664	5.268	6.418	28.499	4.061	7.164
Spotlights	23.939	3.489	6.001	25.118	3.438	6.097	28.966	0.877	7.667
Dark class	30.657	0.364	7.429	32.125	0.340	7.592	32.594	0.262	8.135
Small class	32.353	2.162	8.018	34.095	1.889	8.267	35.465	0.221	8.678
Overall	28.399	1.703	7.243	30.913	1.634	7.406	**33.651**	**0.696**	**8.209**



PanoHDR-NeRF

- Scene as a HDR Radiance Field.Predict radiance and density
- Decompose into foreground and background
- Spherical sampling for omnidirectional images
- NeRF loss between predicted log radiance $\hat{E}$ and GT log radiance E for set of all rays poses $\mathcal{R}(P)$. Training in log space is more stable.

$$\ell_{\text{nerf}} = \sum_{r \in \mathcal{R}(\mathbf{P})} \|\hat{E}(\mathbf{r}) - E(\mathbf{r})\|^2$$

Dataset	Linear loss PU-PSNR↑	Linear loss RMSE↓	PanoHDR-NeRF PU-PSNR↑	PanoHDR-NeRF RMSE↓	NeRF-LDR2HDR PU-PSNR↑	NeRF-LDR2HDR RMSE↓
Chess room	35.152	0.011	36.941	0.012	35.991	0.006
Stairway	31.810	0.055	33.169	0.056	32.707	0.055
Cafeteria	24.139	4.376	28.029	4.179	26.537	5.298
Spotlights	26.719	0.909	28.657	0.431	27.324	1.619
Dark class	28.431	1.367	30.687	1.509	29.819	0.621
Small class	36.829	0.043	37.687	0.054	38.529	0.006
Overall	29.725	1.071	**32.528**	**1.038**	31.650	1.301