4D and Quantum Vision Group
SAARLAND UNIVERSITY
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E-3DGS: Event-Based Novel View Rendering of Large-Scale Scenes Using 3D Gaussian Splatting

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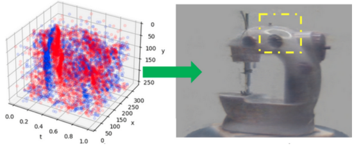
Project Page, Code & Data
4dqv.mpi-inf.mpg.de/E3DGS/

Contributions

- E-3DGS, the first approach for novel view synthesis from a color event camera that combines 3D Gaussians with event-based supervision
- Frustum-based initialization, adaptive event windows, isotropic 3D Gaussian regularization and 3D camera pose refinement
- New synthetic and real event datasets for large scenes to study novel view synthesis in the new problem setting

Related Works



EventNeRF [Rudnev *et al.*, CVPR 2023]

- Supports single object only/Scene extent has to be known in advance
- Comparably slow at training and rendering
- Visual accuracy is behind the RGB-based alternatives

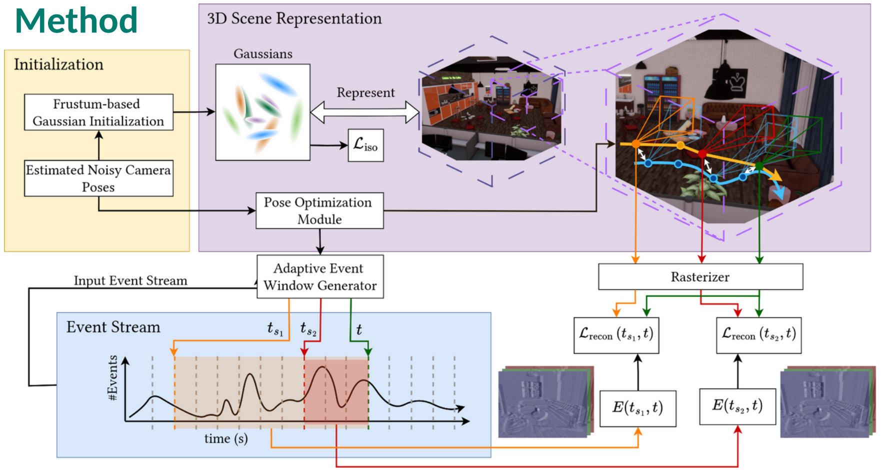
Scene	EventNeRF [25]			E-3DGS (ours)		
	↑PSNR	↓LPIPS	↑SSIM	↑PSNR	↓LPIPS	↑SSIM
Chair	**30.62**	0.05	0.94	30.42	**0.03**	**0.95**
Drums	27.43	0.07	0.91	**31.07**	**0.03**	**0.95**
Ficus	31.94	0.05	0.94	**34.08**	**0.02**	**0.96**
Hotdog	30.26	0.04	0.94	**30.79**	**0.03**	**0.96**
Lego	25.84	0.13	0.89	**30.74**	**0.04**	**0.94**
Materials	24.10	0.07	0.94	**33.73**	**0.02**	**0.97**
Mic	31.78	0.03	0.96	**35.87**	**0.02**	**0.98**
Average	28.85	0.06	0.93	**32.39**	**0.03**	**0.96**

Comparisons on the synthetic EventNeRF dataset.

References:

Rebecq *et al.* High Speed and High Dynamic Range Video with an Event Camera. TPAMI, 2019.
Rudnev *et al.* EventNeRF: Neural Radiance Fields from a Single Colour Event Camera. CVPR 2023.
Low and Lee. Robust e-NeRF: NeRF from Sparse & Noisy Events under Non-uniform Motion. ICCV, 2023.
Kerbl *et al.* 3D Gaussian Splatting for Real-Time Radiance Field Rendering. ACM ToG, 2023.

Method



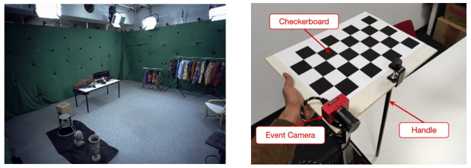
$$\mathcal{L}_{recon}(t_s, t) = \frac{\alpha}{|\mathcal{X}_{noevs}|} \cdot \left(\sum_{\boldsymbol{x} \in \mathcal{X}_{noevs}} \mathcal{L}_{\boldsymbol{x}}(t_s, t) \right) + \frac{1-\alpha}{|\mathcal{X}_{evs}|} \cdot \left(\sum_{\boldsymbol{x} \in \mathcal{X}_{evs}} \mathcal{L}_{\boldsymbol{x}}(t_s, t) \right)$$

$$\mathcal{L} = \lambda_1 \mathcal{L}_{recon}(t_{s_1}, t) + \lambda_2 \mathcal{L}_{recon}(t_{s_2}, t) + \lambda_{iso} \mathcal{L}_{iso} + \lambda_{pose} \mathcal{L}_{pose}$$

Results on Synthetic Data

Method	Company			ScienceLab			Subway			Average		
	↑PSNR	↓LPIPS	↑SSIM	↑PSNR	↓LPIPS	↑SSIM	↑PSNR	↓LPIPS	↑SSIM	↑PSNR	↓LPIPS	↑SSIM
EventNeRF [25]	19.59	0.41	0.65	17.22	0.46	0.60	18.71	0.34	0.67	16.80	0.50	0.61
E2VID [23] + 3DGS [9]	9.79	0.37	0.48	11.86	0.38	0.54	9.79	0.40	0.43	10.48	0.38	0.49
E-3DGS (ours)	**20.78**	**0.29**	**0.72**	**18.41**	**0.28**	**0.73**	**19.92**	**0.20**	**0.74**	**19.70**	**0.26**	**0.73**

New Real Dataset



Results on Real Data