BeSplat: Gaussian Splatting from a Single Blurry Image and Event Stream

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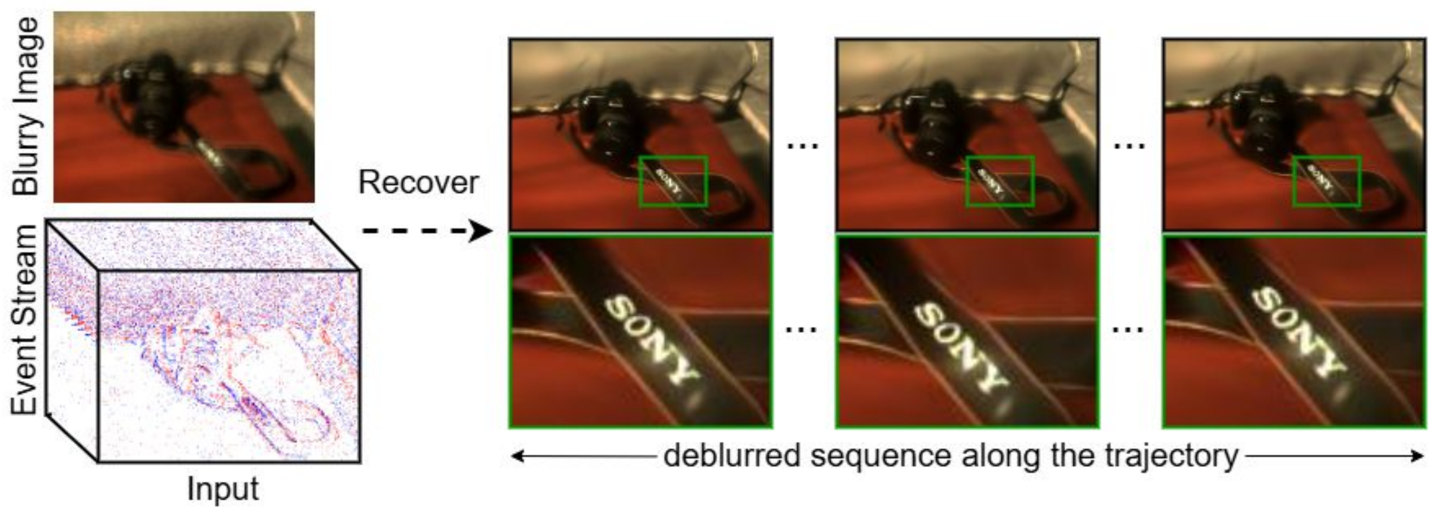
Goal



To synthesize high-quality, sharp images from a single blurry image and its corresponding event stream by leveraging event information to accurately estimate the motion trajectory and restore fine details with enhanced clarity along the camera's trajectory.

Background and Motivation

➢Accurate 3D scene recovery from blurry images is vital but challenging for single views.

➢Event cameras provide high temporal resolution, complementing blurry images effectively.

➢Gaussian Splatting enables fast training, real-time rendering, and sharp 3D reconstruction.

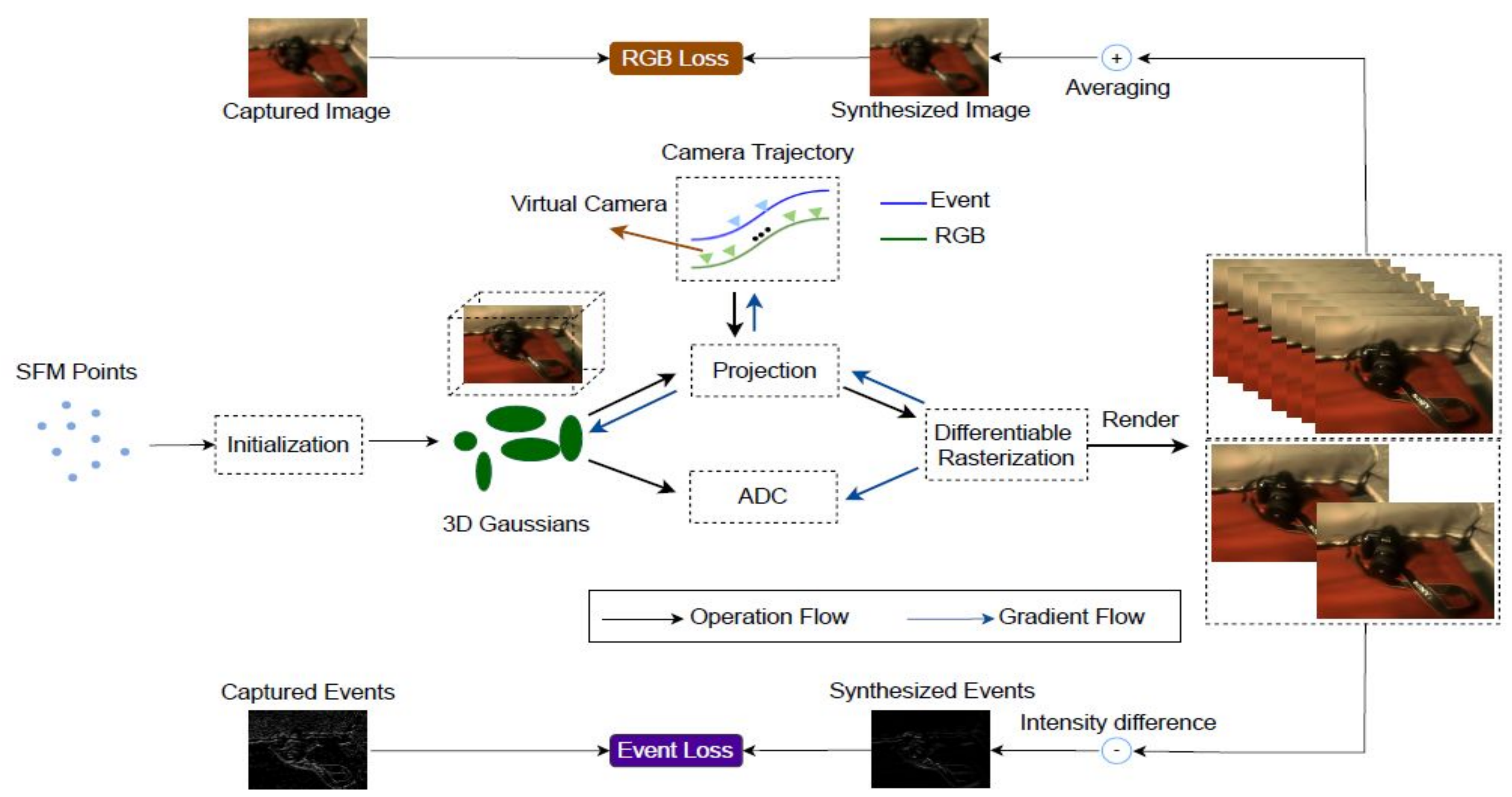
Key contributions

➢Conceptualized single-image motion deblurring as a novel view synthesis problem using Gaussian Splatting and event stream information.

➢Incorporated event loss to accurately estimate camera motion and address the ill-posed nature of single-image deblurring.

➢Achieved faster training, reduced GPU memory usage, and real-time rendering, producing sharp, high-quality novel images along the camera trajectory.

Pipeline



Illustration

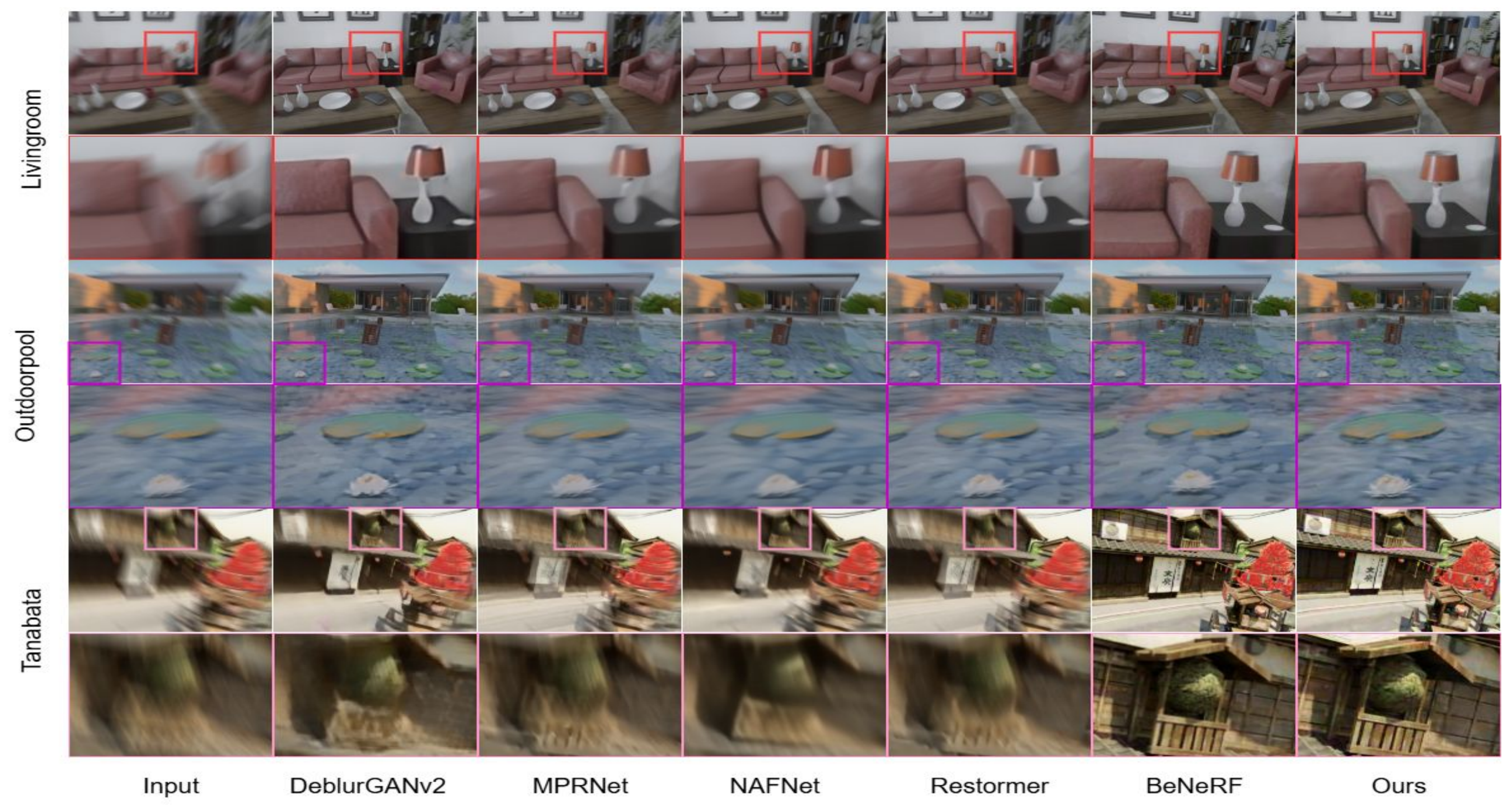
➢The method takes a blurry image and event stream as input to estimate camera motion and reconstruct a sharp 3D scene.

➢Camera motion is modeled with a B´ezier spline, and Gaussian splats are optimized by minimizing photometric and event losses.

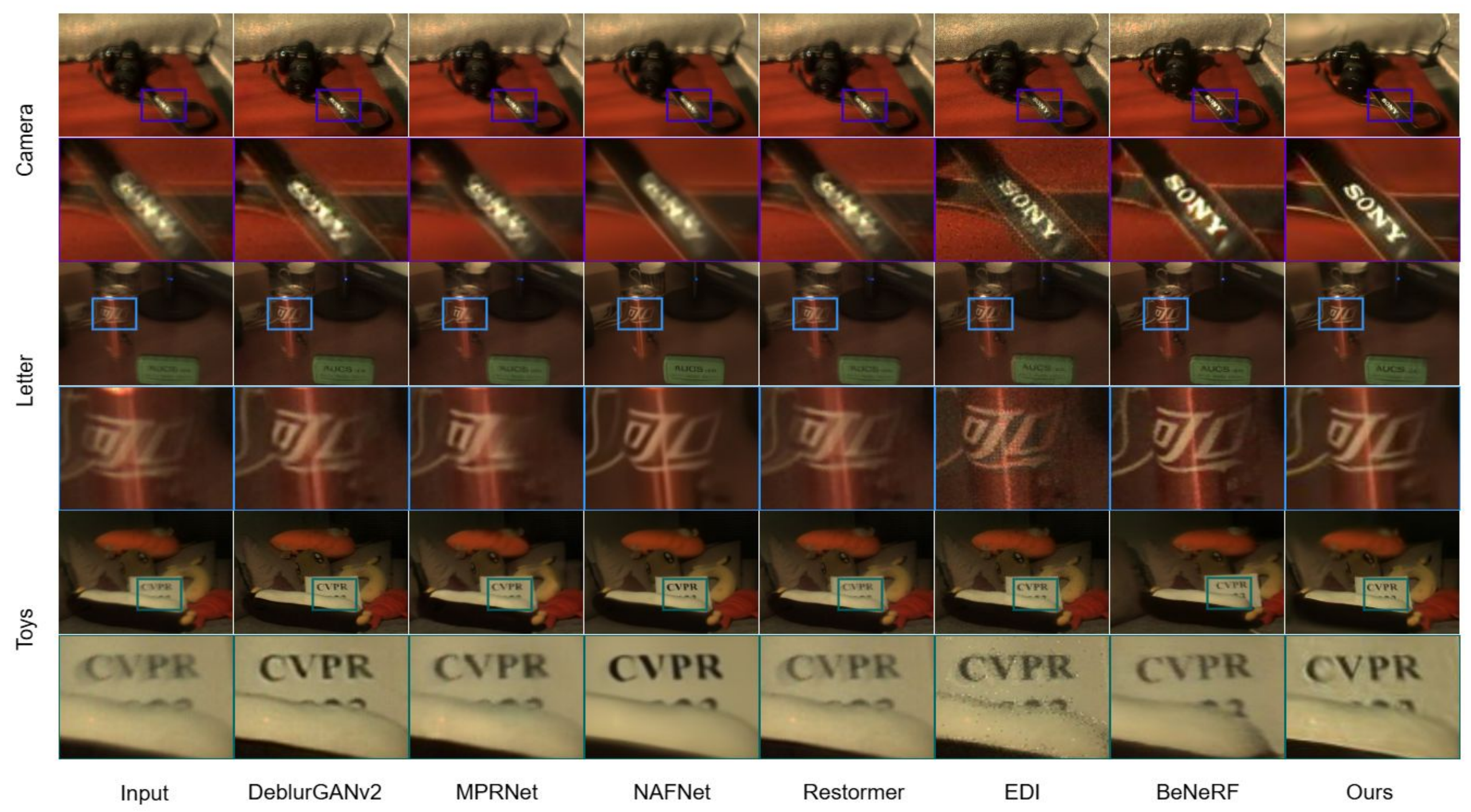
➢Sharp images along the camera trajectory are generated by jointly optimizing the scene representation and motion trajectory.

Qualitative Results

Synthetic Dataset



Real Dataset



Quantitative Results

(a) Memory Usage Comparison with BeNeRF on Real Dataset (GB)

	Camera↓	Lego↓	Letter↓	Plant↓	Toys↓	*Average*↓
BeNeRF [29]	8.65	8.65	8.65	8.65	8.65	8.65
Ours	1.45	1.45	1.45	1.45	1.45	1.45

(b) Training Time Comparison with BeNeRF on Real Dataset (hh:mm)

	Camera↓	Lego↓	Letter↓	Plant↓	Toys↓	*Average*↓
BeNeRF [29]	06.20	06.25	06.25	06.30	06.25	06.25
Ours	01.30	01.25	01.30	01.35	01.30	01.30

(c) Comparison of Deblurring Methods Based on PSNR, SSIM, and LPIPS Metrics

	Livingroom			Tanabata		
	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓
DeblurGANv2 [25]	29.26	.8121	.2087	20.09	.4964	.3934
MPRNet [64]	28.57	.7937	.2621	18.20	.4258	.4173
NAFNet [7]	29.92	.8306	.2268	18.96	.4665	.3908
Restormer [63]	29.48	.8262	.2391	18.82	.4596	.4248
EDI [41]	32.61	.8871	.0904	24.87	.7564	.1039
BeNeRF [29]	37.11	.9370	.0632	32.14	.9015	.0515
Ours	35.14	.9111	.1189	29.15	.8626	.1015