3D-HGS: 3D half gaussian splatting

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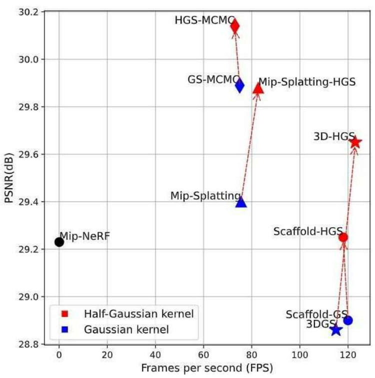
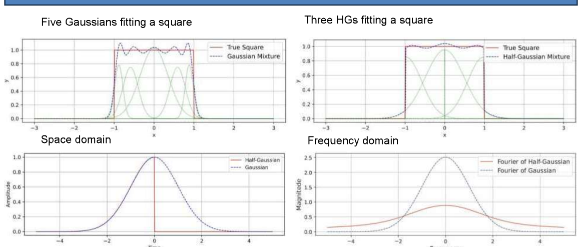
Motivation



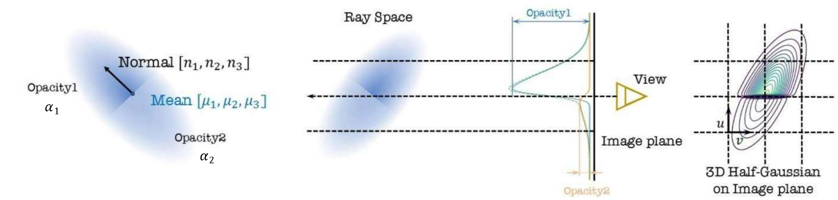
- **3D half gaussian splatting:**
  - •Introduces a cutting plane to enhance shape and color boundary representation.
  - •Improves modeling of discontinuities in 3D Gaussian Splatting.
  - •Designed as a plug-and-play kernel, compatible with other Gaussian Splatting methods.

Comparison of Half-Gaussian and Gaussian Kernels



Time Domain: Half-Gaussians better approximate sharp edges with fewer kernels and lower error.
Frequency Domain: Preserve more high-frequency components, improving edge fidelity.

Our Method: 3D-HGS



	3DGS	3D-HGS
Parameters	$\mu \in R^{1*3}, \Sigma \in R^{3*3}$	$\mu \in R^{1*3}, \Sigma \in R^{3*3}, n \in R^{1*3}$
Kernel	$G_\Sigma(x-\mu) = \alpha\, e^{-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)}$	$H\hat{G}(\hat{x}-\hat{\mu}) = \frac{1}{2}\{2\alpha_2 + (\alpha_1-\alpha_2)I(x,y)\}\hat{G}_{\hat{\Sigma}}(\hat{x}-\hat{\mu})$
Projection to 2D	$G_\Sigma(x-\mu) = e^{-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)}$	$HG_\Sigma(x-\mu) = \begin{cases} e^{-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)} & n^T(x-\mu) \ge 0 \\ 0 & n^T(x-\mu) \le 0 \end{cases}$

Quantitative Results

Dataset	Mip-NeRF360			Tanks&Temples			Deep Blending		
Method	PSNR ↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓	PSNR↑	SSIM↑	LPIPS↓
Mip-NeRF [1]	29.23	0.844	0.207	22.22	0.759	0.257	29.40	0.901	0.245
2D-GS[8]	28.98	0.867	0.185	23.43	0.845	0.181	29.70	0.902	0.250
Fre-GS [30]	27.85	0.826	0.209	23.96	0.841	0.183	29.93	0.904	0.240
GES [6]	28.69	0.857	0.206	23.35	0.836	0.198	29.68	0.901	0.252
3D-GS [9]	28.88	0.870	0.182	23.60	0.847	0.181	29.41	0.903	0.243
3D-**HGS** (**Ours**)	29.66 **+0.78**	0.873	0.178	24.45 **+0.85**	0.857	0.169	29.76 **+0.35**	0.905	0.242
Scaffold-GS [15]	28.95	0.848	0.220	23.96	0.853	0.177	30.21	0.906	0.254
Scaffold-**HGS**(**Ours**)	29.25 **+0.30**	0.867	0.186	24.42 **+0.46**	0.859	0.162	30.36 **+0.15**	0.910	0.240
Mip-Splatting [29]	29.39	0.880	0.162	23.75	0.857	0.157	29.46	0.903	0.243
Mip-Splatting-**HGS**(**Ours**)	29.88 **+0.49**	0.881	0.160	24.53 **+0.78**	0.865	0.145	29.61 **+0.15**	0.901	0.241
GS-MCMC [10]	29.89	0.900	0.190	24.29	0.860	0.190	29.67	0.890	0.320
HGS-MCMC(**Ours**)	30.13 **+0.24**	0.886	0.158	25.08 **+0.77**	0.841	0.144	29.80 **+0.13**	0.898	0.245

Qualitative Results