# GeoGaussian: Geometry-aware Gaussian Splatting for Scene Rendering

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## **Overfitting Problems in 3DGS** What:

Google

The 3D Gaussian Splatting methods optimized with photometric constraints generally overfit to the training views, resulting in inconsistent performance when rendering novel views.



The ceiling light rendered from different viewpoints.

### Why:

1.Regions with low-textured or repeat patterns are changlenging to photometric-only supervision.

2. The densification module often produces Gaussian floaters to enhance color information, but it ignores the original structures.

## Codes and datasets are at https://github.com/yanyan-li/GeoGaussian

#### Methodology of GeoGaussian modified smooth area normal direction neares Yneighbors direction **Clone on Tangent space** 3D Position: $\mu$ Scales: $\mathbf{S} = [s_1 \ s_2 \ 0.001]^T$ Rotation: $\mathbf{R} = [\mathbf{r}_1 \ \mathbf{r}_2 \ \mathbf{n}]$ Spherical Harmonics: C **Co-planar** Constraint Opacity: $\alpha$ Split on Tangent space

In this work, we introduce a novel pipeline to initialize thin Gaussians aligned with the surfaces, where the characteristic can be transferred to new generations through a carefully designed densification strategy. The pipeline ensures that the scene geometry and texture are maintained through constrained optimization processes with explicit geometry constraints.

Densification



Parametrization of Thin Gaussians

GeoGaussian achieves significantly better results in the first 15K iterations than 3DGS. This improvement can be attributed to the accuracy provided by our proposed initialization and densification modules. The performance of GeoGaussian is more robust in both sparse (10%) and full (100%) training data scenarios.

Smooth Constraint

# Point Clouds from PlanarSLAM



Li, Yanyan, et al. "RGB-D SLAM with structural regularities." IEEE ICRA2021.

### **Rendering Performance** Replica OFF2 Replica OFF0 3DGS LightGS Ours Reference Methods R1 (PSNR) R2 (PSNR) Data size 10% 16.6% 50% 10% 16.6% 50% 3DGS 30.49 33.98 37.45 31.53 35.82 38.53

## **More Results** Wild scenes

Ours

**Gaussian position** 

32.13 36.81 38.84



red: 3DGS green: ours

### Depth estimation and scene recon.

31.65 35.17 38.00



Mip-NeRF360

Ours