Supplementary Material

In the supplementary material, we provide additional qualitative examples and video results across various datasets, along with an evaluation of inference efficiency. The materials are organized as follows:

- **LLFF.** Additional visual results are provided in Section 1, with video demos included in `LLFF.zip` and on the anonymous project website.
- **Tanks&Temples.** See Section 2 for more qualitative comparisons. Corresponding video results are available in `Tanks&Temples.zip` and on the anonymous project website.
- **Mip-NeRF360.** Section 3 presents further examples. Videos are included in `Mip-NeRF360.zip` and on the anonymous project website.
- **Inference Efficiency.** A comparison of inference speed across different methods is provided.

1 LLFF

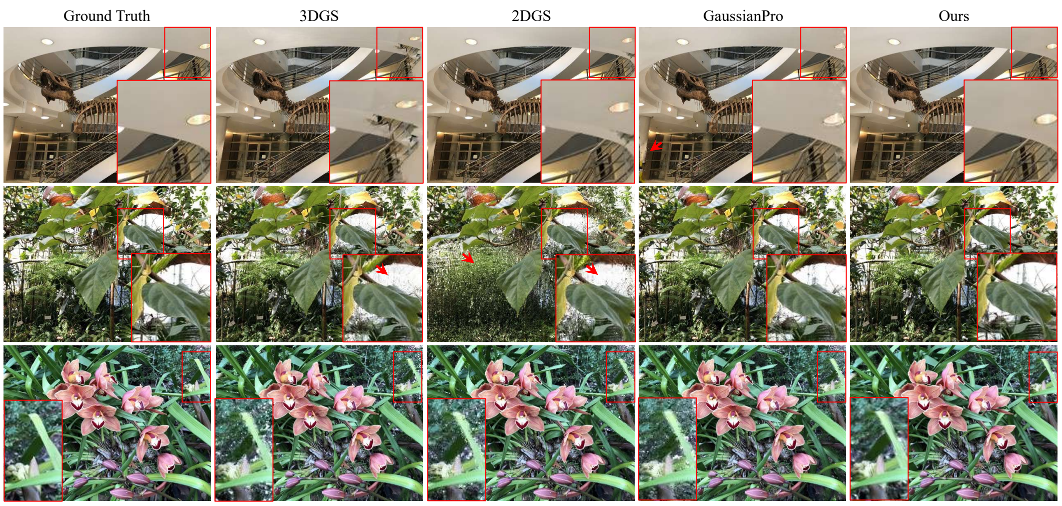

Figure 14: Additional qualitative comparison on LLFF. 3DGS can lead to inaccurate scene geometry. While 2DGS improves geometric fidelity, it overlooks texture and high-frequency details. EGGS recovers more accurate geometry while preserving high-frequency details.

As shown in Figure 14, 3DGS often suffers from inaccurate scene geometry, leading to distorted walls and blurred edges due to its reliance on anisotropic 3D Gaussians without explicit geometric constraints. 2DGS, by contrast, improves geometric fidelity and produces sharper surfaces and more coherent structural boundaries, but tends to oversmooth fine-scale textures and loses high-frequency details, resulting in flatter appearance. GaussianPro enhances geometric reconstruction through regularization, but may introduce ringing artifacts or overfitting to specific structures. In contrast, EGGS effectively balances geometry and appearance: it captures accurate scene structure while preserving fine details such as textures and edges. This demonstrates the advantage of using a hybrid representation that dynamically leverages the strengths of both 2D and 3D Gaussians. As shown in our video examples, EGGS achieves more accurate scene geometry, with Gaussians better aligned to surfaces and significantly fewer floaters compared to baseline methods.

2 Tanks&Temples

As shown in Figure 15, 3DGS often produces unclear or distorted edges, particularly along building boundaries, due to imprecise geometry modeling with unconstrained anisotropic Gaussians. This geometric inaccuracy can sometimes even lead to missing or poorly reconstructed structural details. On the other hand, 2DGS improves geometric fidelity and captures sharper building contours, but tends to blur textures and overlook high-frequency details, resulting in over-smoothed surfaces. GaussianPro

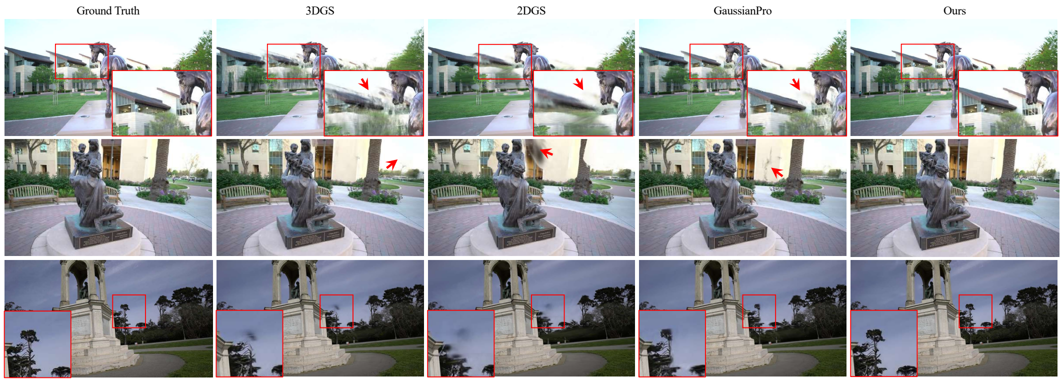

Figure 15: Additional qualitative comparison on Tanks&Temples. 3DGS can lead to blurred outlines of buildings. 2DGS often overlooks high-frequency details. EGGS recovers more accurate geometry while preserving high-frequency details.

introduces geometric regularization to mitigate these issues and shows improved reconstruction quality; however, it can still produce artifacts or introduce local inconsistencies. In contrast, EGGS explicitly decouples the representation by assigning 2D Gaussians to capture coarse geometry and 3D Gaussians to refine local details. This division allows each Gaussian type to specialize, leading to more accurate surface alignment and preservation of fine structures. Our method yields clearer building edges, faithful textures, and fewer floaters, as also demonstrated in the video results.

3 Mip-NeRF360

Figure 16: Additional qualitative comparison on Mip-NeRF360. 3DGS struggles to recover accurate surfaces, often producing distorted or incomplete geometry. While flattened representations like 2DGS better capture surface structures, they tend to oversmooth textures and lose high-frequency details. In contrast, EGGS recovers more accurate geometry while preserving fine appearance details.

As shown in Figure 16, single-representation methods struggle to simultaneously capture accurate scene geometry and fine-grained visual details. 3DGS, when responsible for modeling both large-scale structure and appearance, often fails to preserve high-frequency textures, leading to blurred or incomplete details. In contrast, 2DGS better captures structural consistency through multi-view alignment but tends to produce overly smooth and textureless regions due to its limited volumetric expressiveness. GaussianPro introduces geometric regularization to address these issues but can still produce artifacts when its propagation mechanism fails. In comparison, EGGS assigns 2D Gaussians to encode global geometry and 3D Gaussians to refine local visual detail. This separation allows each Gaussian type to specialize, resulting in sharper scene structure, enhanced textures, and overall higher-fidelity reconstructions.

Table 10: Comparison of inference efficiency. We report the average FPS in each dataset.

Method	LLFF	Tanks&Temples	Mip-NeRF360.
3DGS	323	158	145
2DGS	187	59	76
GaussianPro	308	166	121
EGGS	268	125	104

4 Inference Efficiency

As shown in Table 10, we compare the rendering efficiency of different methods in terms of frames per second (FPS). During training, the number of parameters significantly impacts performance, as backpropagation and parameter updates are computationally expensive. In contrast, inference efficiency is primarily determined by the rasterization strategy. 3DGS-based methods, including GaussianPro, employ affine projection-based rasterization, which is efficient but less accurate, resulting in higher FPS at inference. Since both 3DGS and GaussianPro use the same projection-based rasterization pipeline, the difference in their inference speed mainly arises from model size—that is, the number of Gaussians used. While the number of primitives affects performance, its influence remains moderate given the similar scale of models.

In contrast, 2DGS adopts a ray–splat–intersection rasterization pipeline, which provides improved geometric accuracy but is more computationally intensive, resulting in slower rendering. EGGS integrates both 2DGS and 3DGS rasterization strategies in a hybrid manner, achieving a favorable balance between accuracy and efficiency. While EGGS 's FPS is slightly lower than that of 3DGS, it remains significantly faster than 2DGS. Additionally, EGGS benefits from a shorter training time than 3DGS, owing to its reduced model size and more effective optimization dynamics.