Temporally Compressed 3D Gaussian Splatting for Dynamic Scenes

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TL;DR: TC3DGS compresses dynamic 3DGS representation using novel pruning, mixed-precision quantization and post-processing techniques.

1 Introduction

Real-time AR/VR and mobile systems need lightweight models.
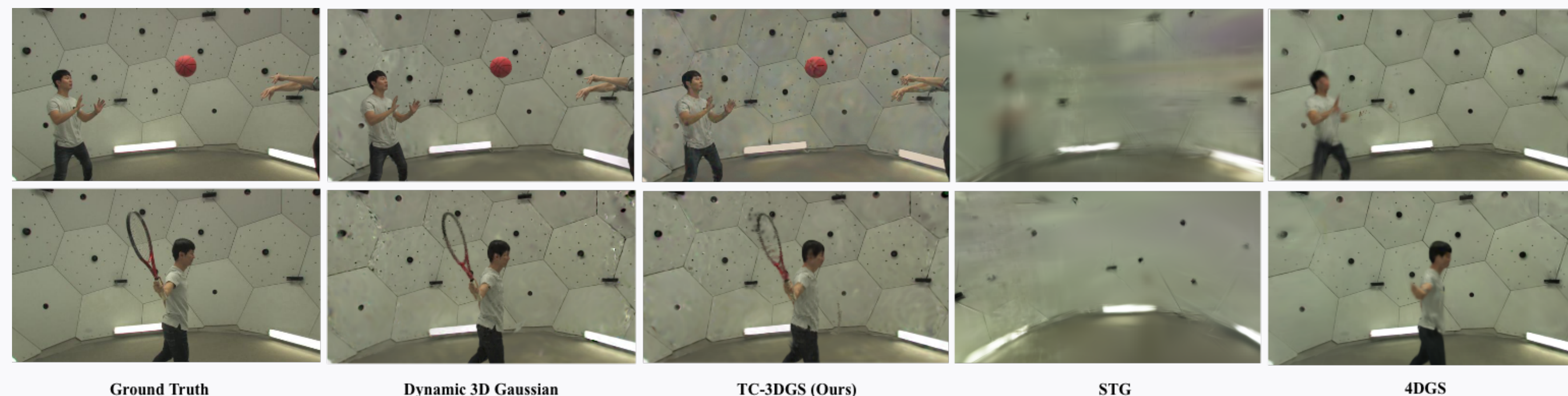
Storing dynamic 3D Gaussian scenes:

- Explicit trajectories → huge file size (5 sec = ~2GB)
- Implicit transformations → fail on complex motion

Compression enables faster rendering and broader deployability.
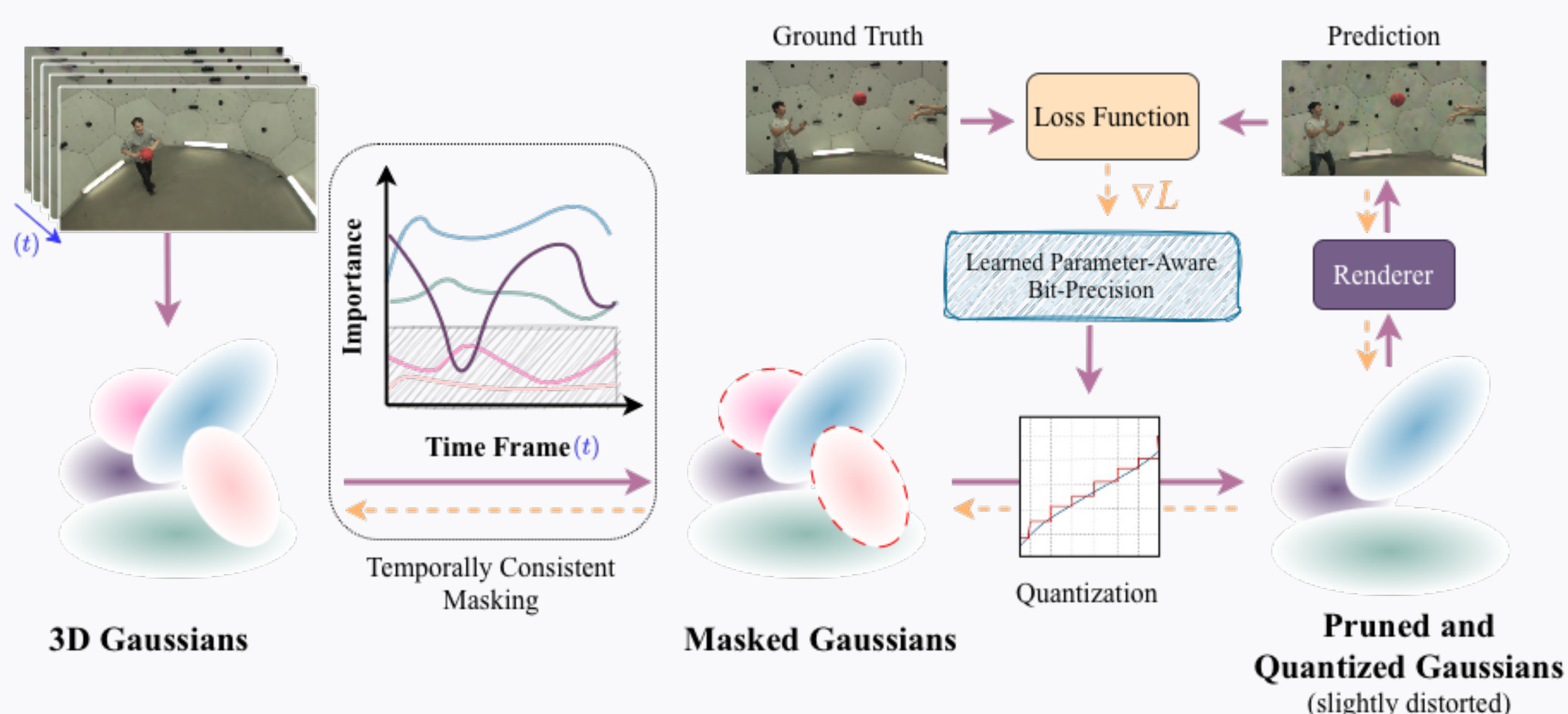
2 Challenges

1. Neural network based deformation fields
   - Inherent bias towards smooth trajectory → **Fails on complex motion**

2. Store frame wise deformations
   - Redundant information stored → **Excessive storage requirements**

Ground Truth   Dynamic 3D Gaussian   TC-3DGS (Ours)   STG   4DGS

3 Method

- Temporal relevance pruning
- First use of mixed-precision quantization for Gaussian parameters
- Interpolate Gaussian trajectories and minimize redundancy

3D Gaussians — Temporally Consistent Masking — Masked Gaussians — Quantization — Pruned and Quantized Gaussians (slightly distorted)

Ground Truth — Loss Function ← Prediction — ∇L — Learned Parameter-Aware Bit-Precision — Renderer

4 Components

1. Gaussian Masking and Pruning

Regularize → Maximally use important gaussians from previous frame

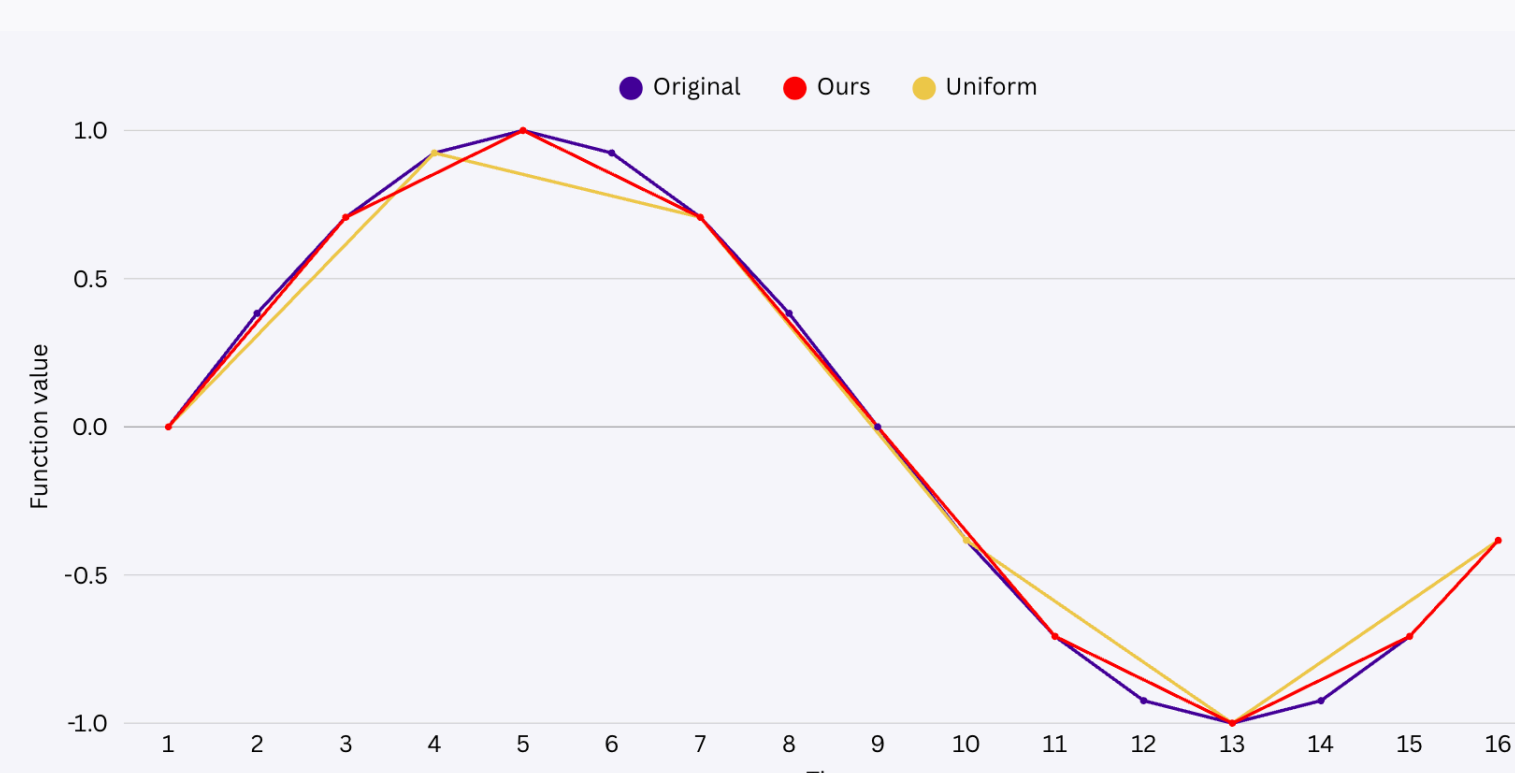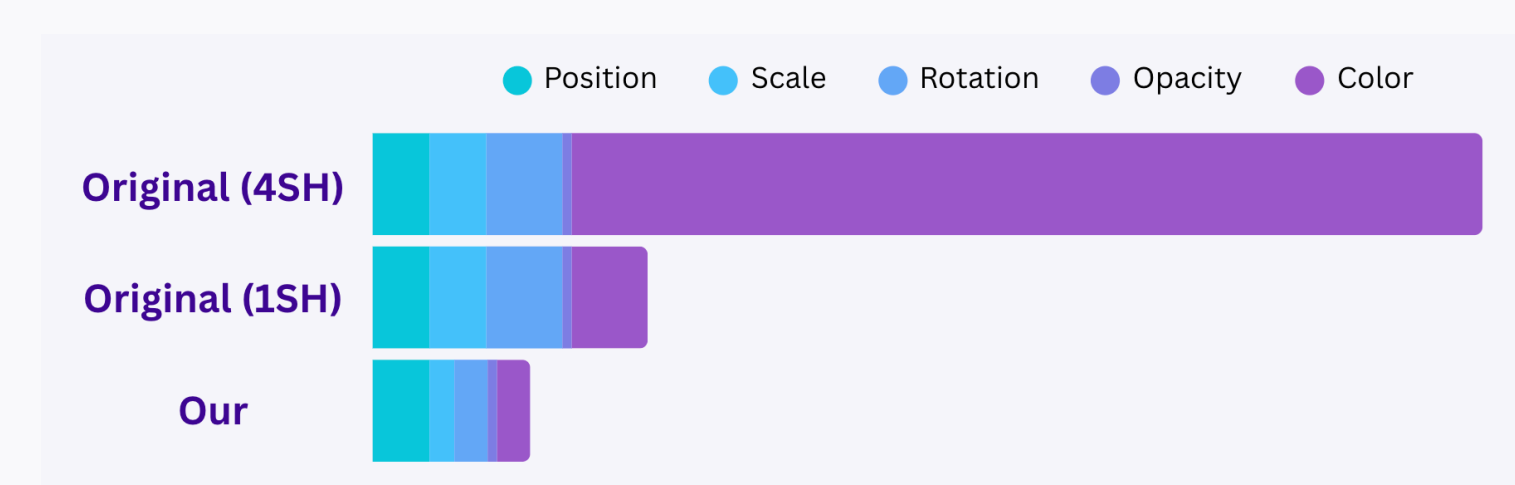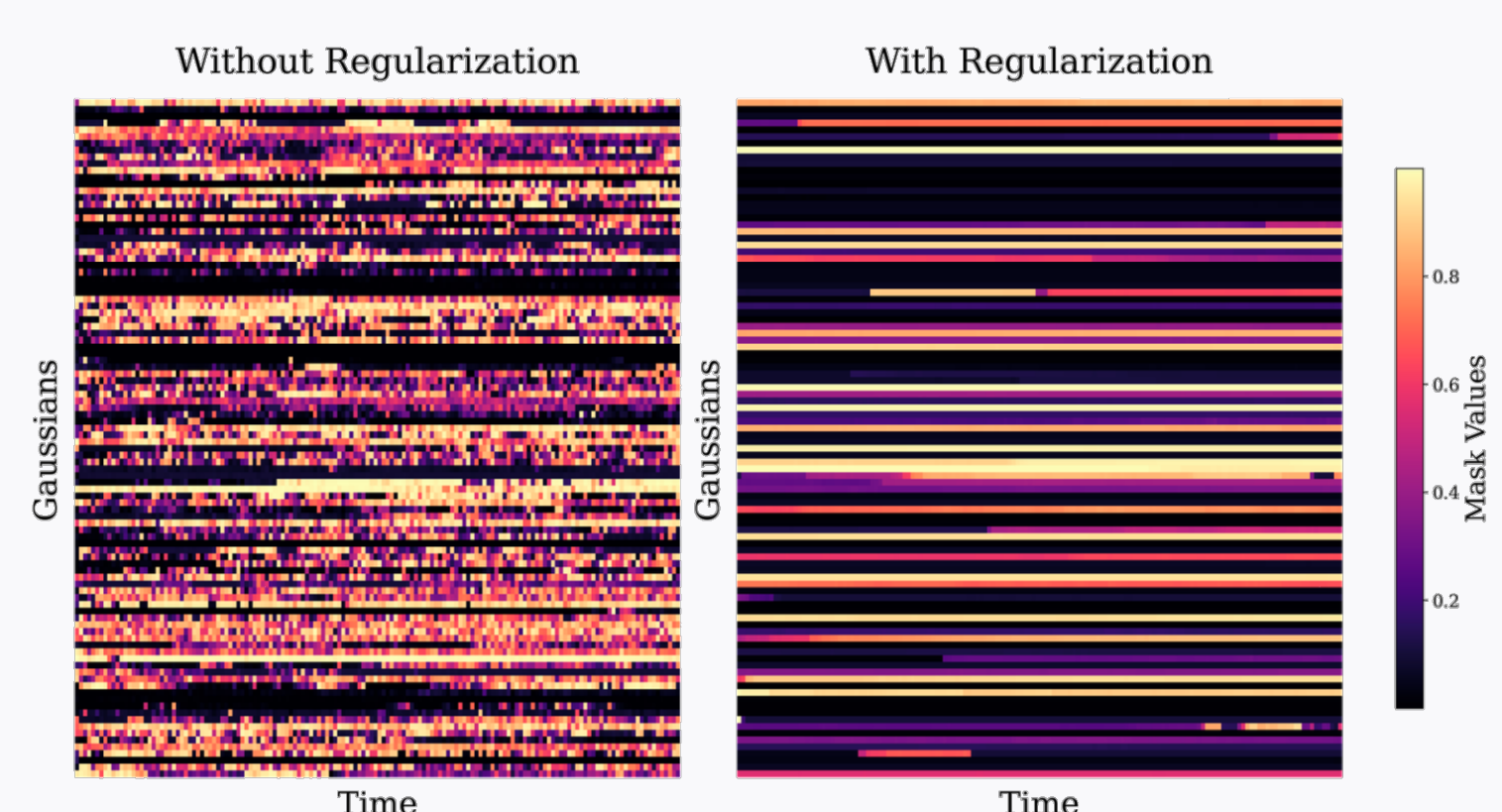$$\mathcal{L}_{mc} = \sum_{n=1}^{N} |m_{n,t} - sg(m_{n,t-1})|.$$

2. Sensitivity Aware Quantization

Sensitivity aware, gradient based, mixed precision method.

$$S(\theta) = \frac{1}{\sum_{k=1}^{K} N_k} \sum_{k=1}^{K} \left| \frac{\partial Q_k}{\partial \theta} \right|.$$

3. Keypoint based Trajectory Compression

An extended Ramer–Douglas–Peucker algorithm that selects keypoints based on error tolerance or a maximum keypoint limit.
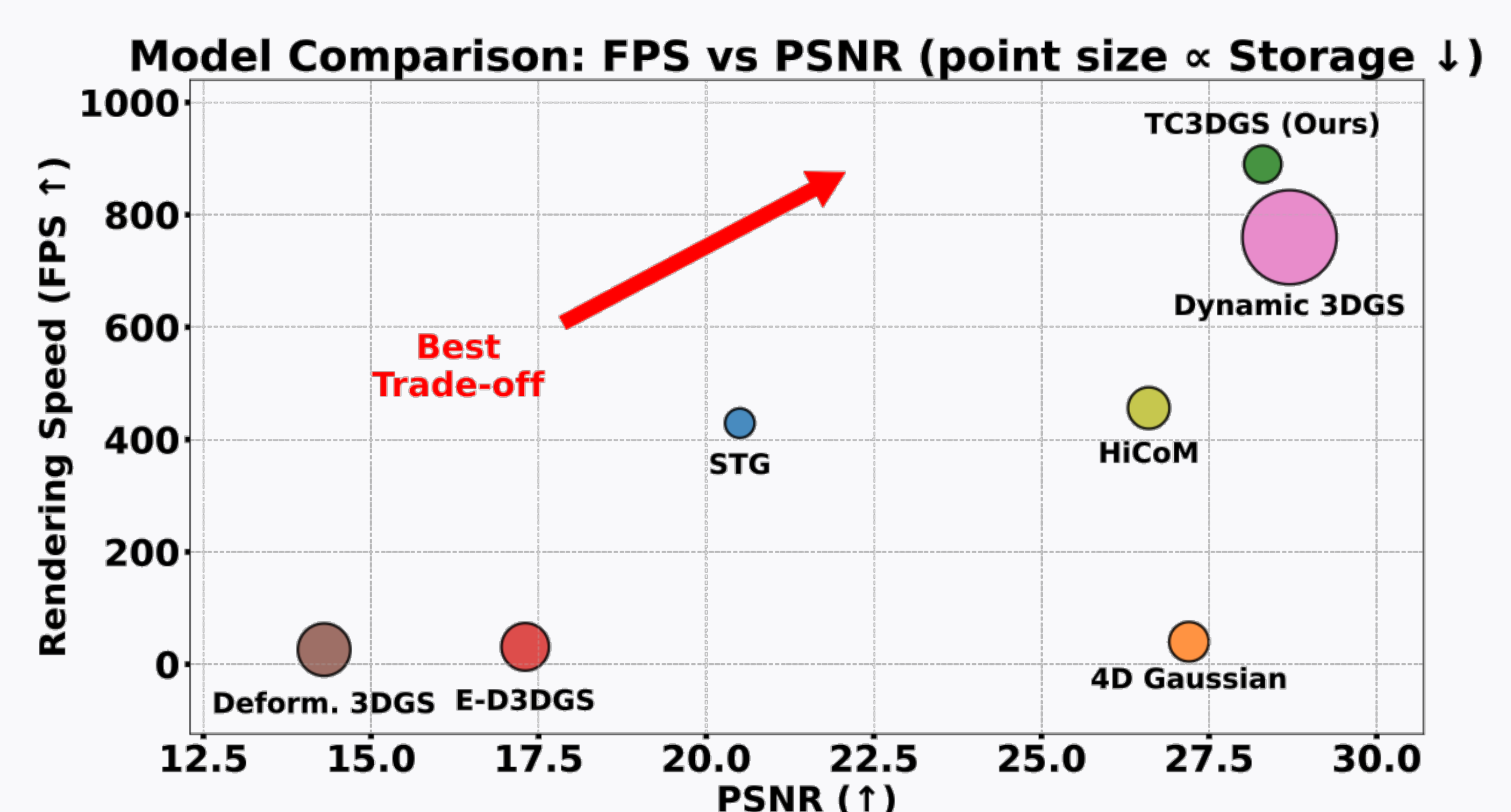

Without Regularization   With Regularization

Position Scale Rotation Opacity Color

Original (4SH)
Original (1SH)
Our

Original Ours Uniform

5 Results

1. SOTA comparison

Method	Panoptic Dataset			Neural 3D Video Dataset		
	PSNR ↑	FPS ↑	Storage ↓	PSNR ↑	FPS ↑	Storage ↓
STG	20.5	429	**19MB**	**32.04**	273	175MB
4D Gaussian	27.2	40	62MB	31.15	30	90MB
E-D3DGS	17.3	31	130MB	31.20	69	<u>40MB</u>
Deform. 3DGS	14.3	26	192.6MB	30.97	29	**33MB**
Dynamic 3DGS	**28.7**	<u>760</u>	1994MB	<u>31.38</u>	<u>460</u>	2772MB
HiCoM	26.6	456	71MB	31.17	247	270MB
TC3DGS (Ours)	<u>28.3</u>	**890**	<u>49MB</u>	30.96	**596**	51MB

2. Trade off Comparison

Model Comparison: FPS vs PSNR (point size ∝ Storage ↓)

Best Trade-off

TC3DGS (Ours), Dynamic 3DGS, STG, HiCoM, Deform. 3DGS, E-D3DGS, 4D Gaussian

3. Qualitative Comparison

582 FPS   2161 MB   750 FPS   46 MB
47 x Compression   28.2 PSNR   27.9 PSNR

760 FPS   1935 MB   912 FPS   32 MB
67 x Compression   29.5 PSNR   29.2 PSNR

Dynamic 3DGS   TC3DGS (Ours)

Check out interactive comparisons:

EPFL   CVLab   BMVC 2025