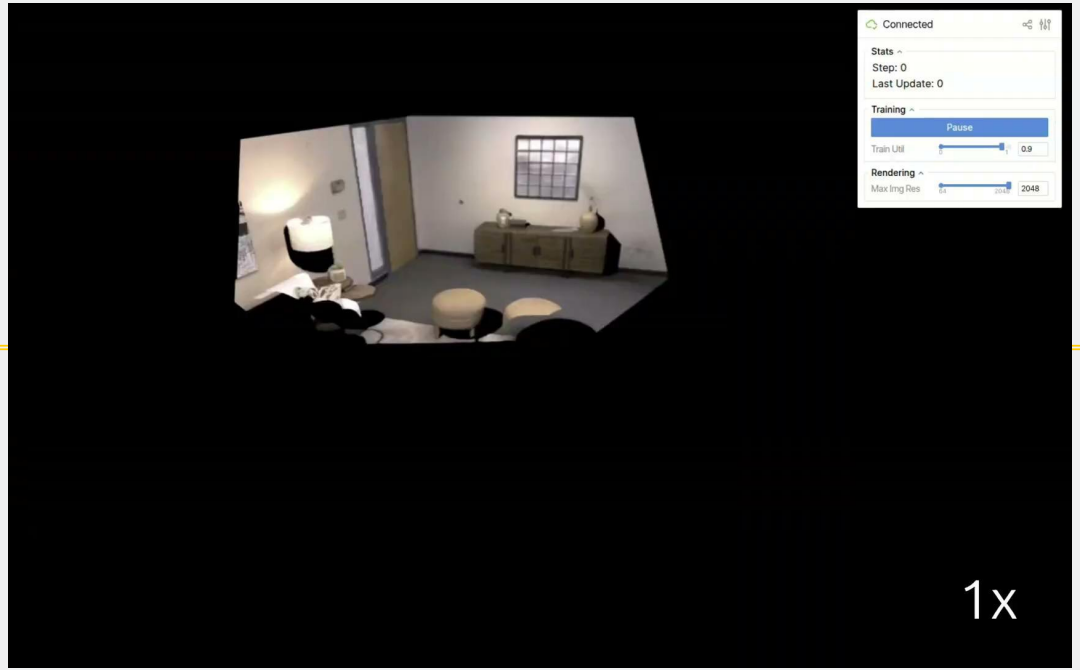
gsplatam
Real-time Splat, Track, and Map with gsplat

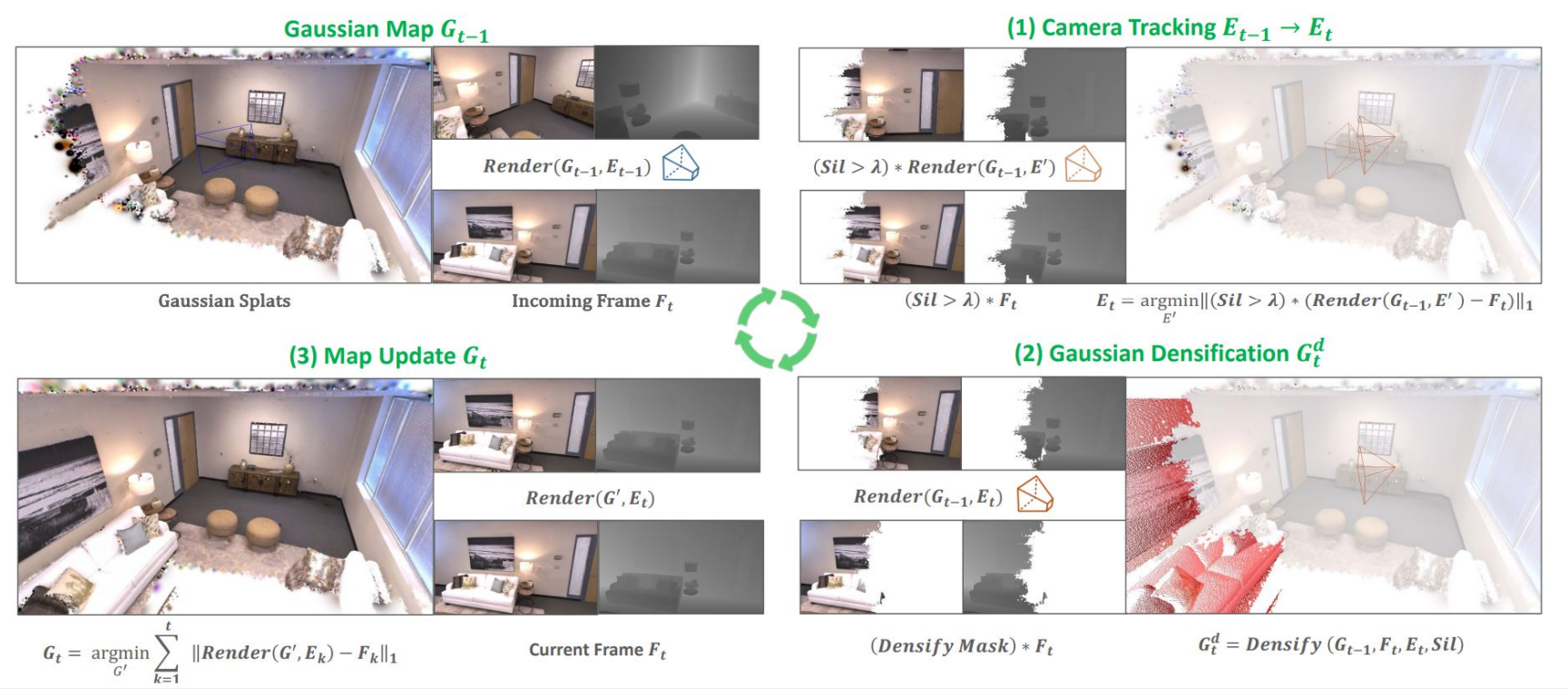


Chahyon Ku, David Wang, Ruihan Chen, Yicheng Zou

April 2025

ROBOTICS

Motivation



Keetha et al. SplaTAM: Splat, Track & Map 3D Gaussians for Dense RGB-D SLAM. (CVPR 2024)

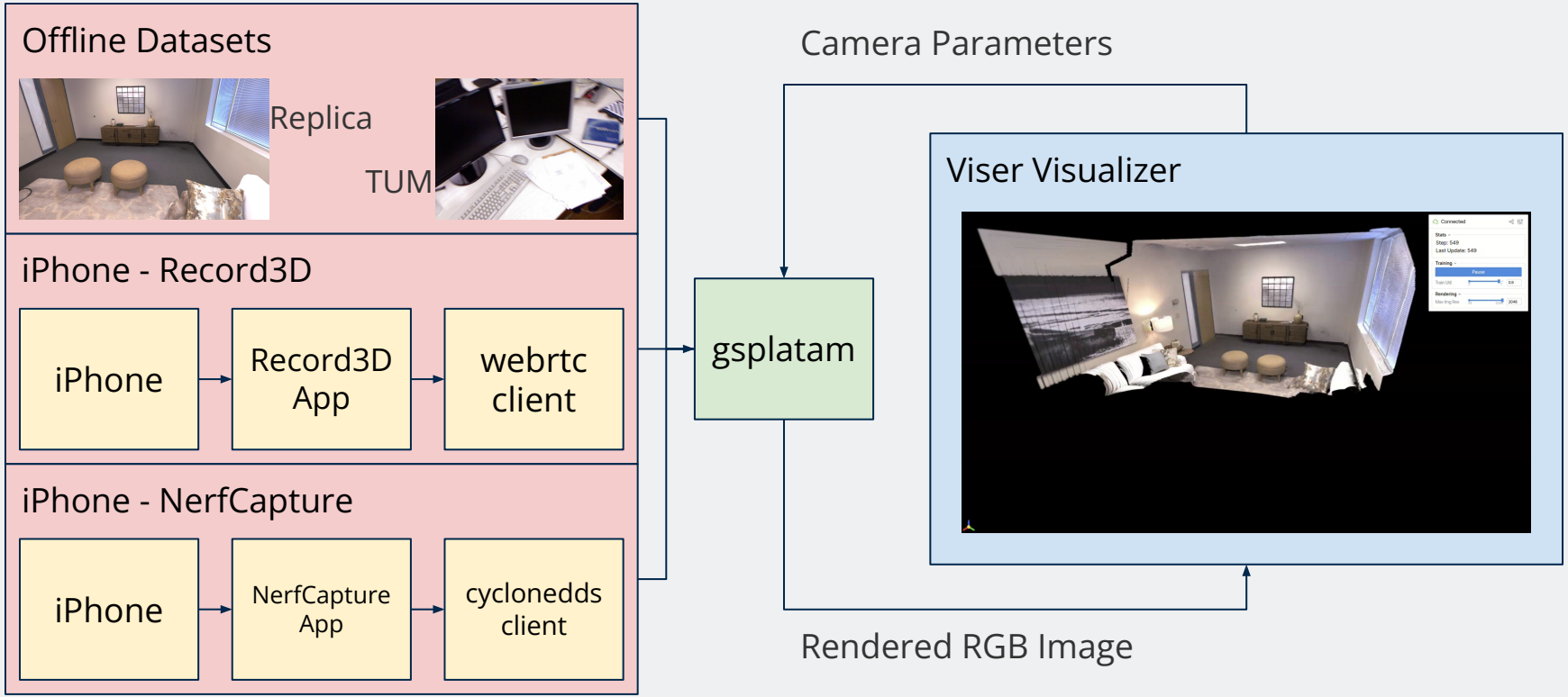
M | ROBOTICS

Motivation

+ High Quality Reconstruction
+ Simple

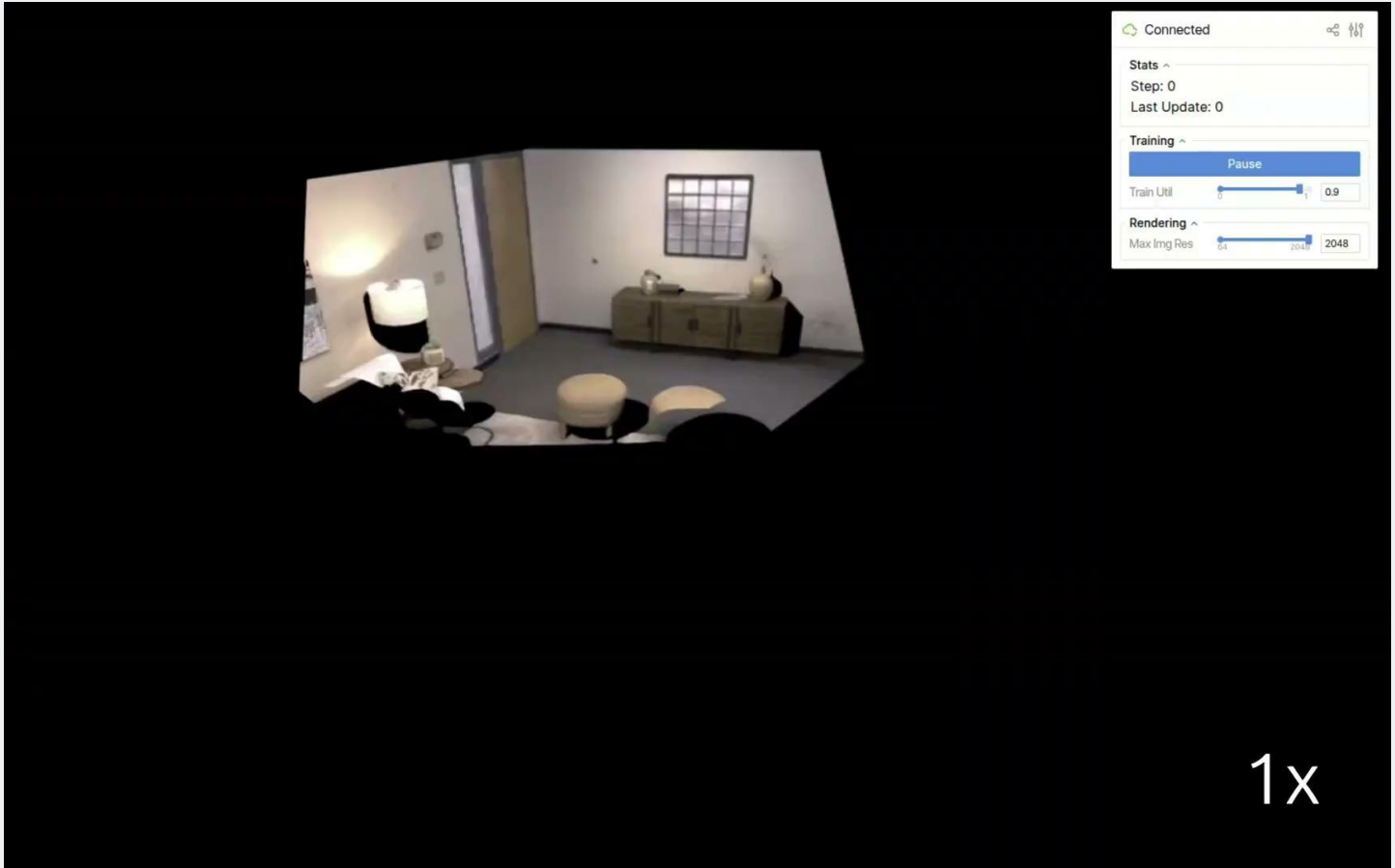
– Lack of Online Interactive Visualization
– Slow
– 3D Gaussians Geometrically Inaccurate

Method: Visualization



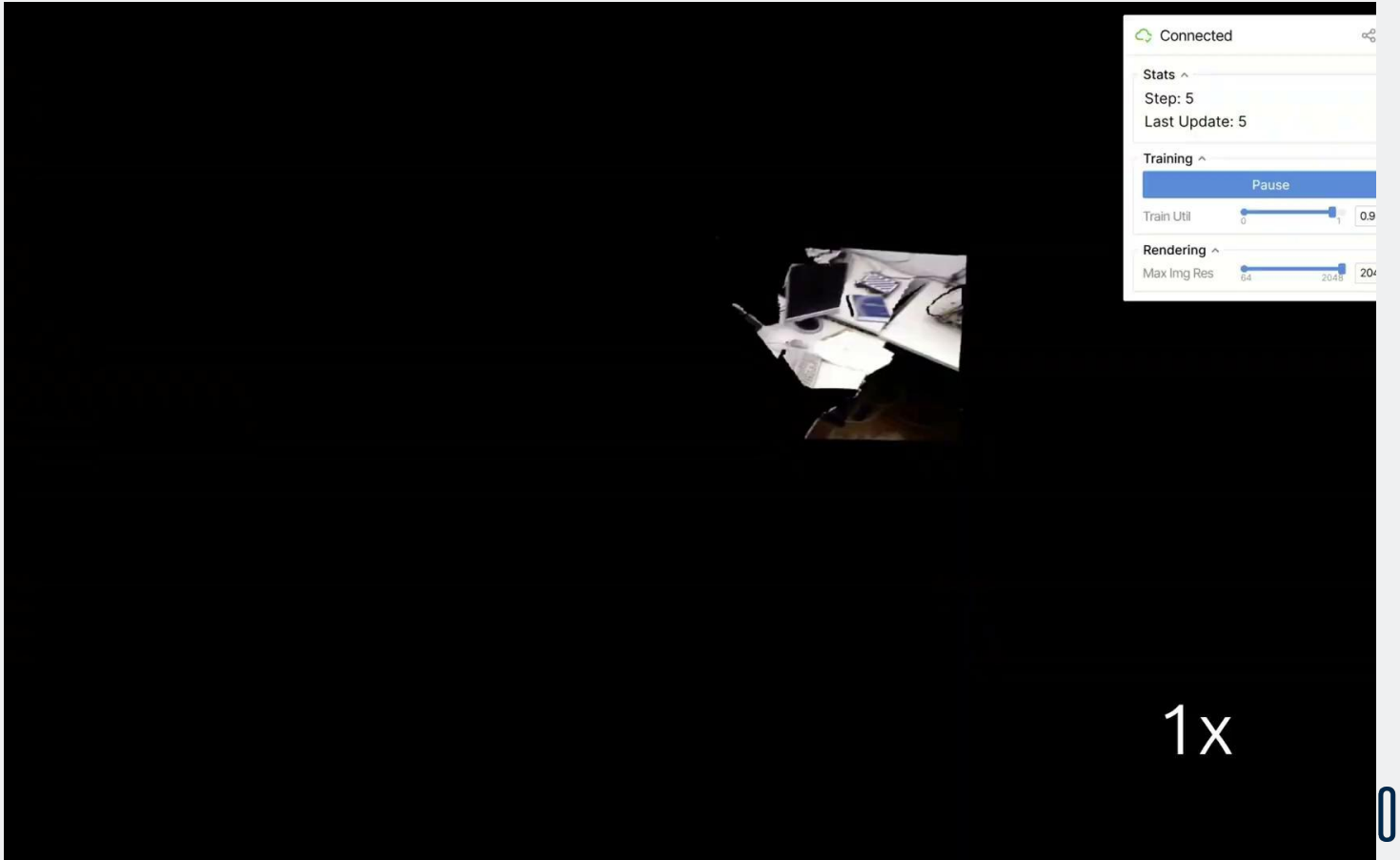
Nerf Studio Team. Viser: a Library for Interactive 3D Visualization in Python. (Github 2023)

Replica Dataset (tiny, 10.5 fps, 1200x680)



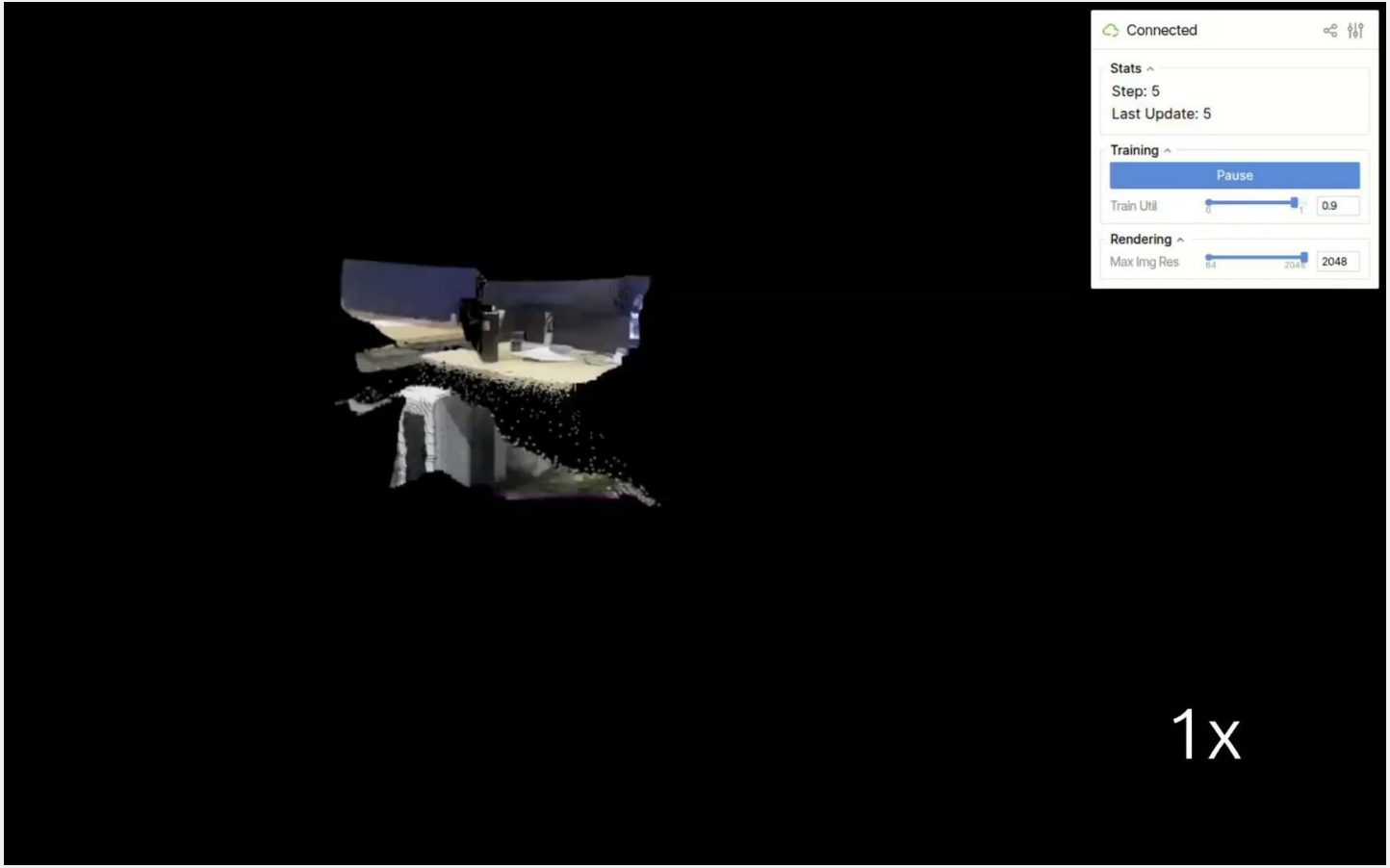
OBOTICS

TUM Dataset (base, 1.27 fps, 640 x 480)



OBOTICS

IPAD Record3D (tiny, 15 fps)



OBOTICS

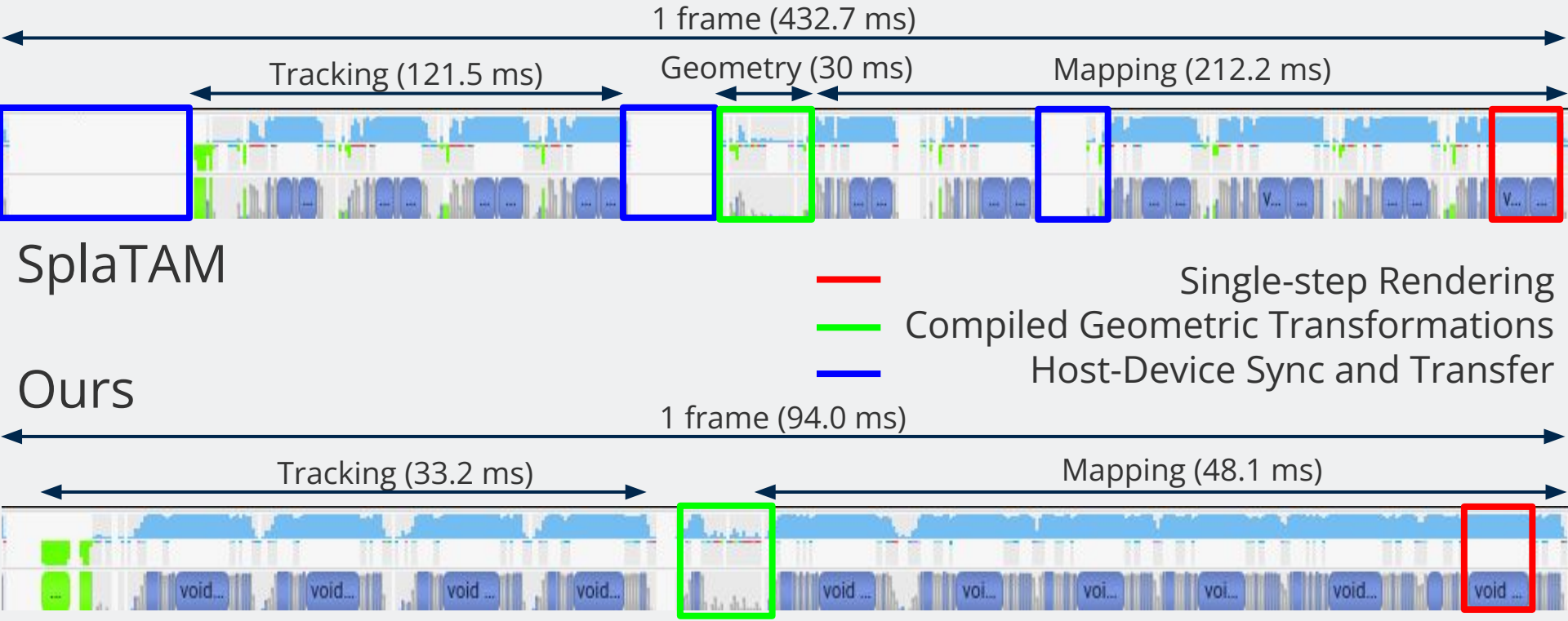
Results: IPAD - NerfCapture

1 fps Posed RGBD Stream over WIFI from iPad

David’s Video!

M | ROBOTICS

Method: Runtime Optimization



gsplat: An Open-Source Library for Gaussian Splatting (arXiv 2024)
NVIDIA Nsight Systems. https://developer.nvidia.com/nsight-systems.

M | ROBOTICS

Results: Replica Dataset

Settings vary based on # of optimization steps

- Base (40/60) vs. Small (10/15) vs. Tiny (4/6)

Setting	Methods	Track Time (s/frame) ↓	Map Time (s/frame) ↓	Total Time (s/frame) ↓	Num Gaussians ↓	ATE RMSE (cm) ↓	PSNR (db) ↑	Depth L1 (cm) ↓
base	reported	1.00	1.44	-	-	0.27	32.81	0.49
	reproduced	2.74	4.94	7.85	5,085,417	0.32	32.48	0.51
	ours	0.32	0.59	0.93	973,059	0.05	35.78	0.25
small	reported	0.19	0.33	-	-	0.39	-	-
	reproduced	0.27	0.45	0.84	931,214	0.52	29.29	0.83
	ours	0.08	0.14	0.24	1,101,708	0.28	30.44	0.55
tiny	reported	-	-	-	-	-	-	-
	reproduced	0.10	0.17	0.39	880,241	6.40	22.97	4.31
	ours	0.03	0.05	0.10	954,972	0.26	22.92	3.28

M | ROBOTICS

Results: Replica Dataset

- Reported — Reported Results from Desktop 3080 Ti
- Reproduced — Evaluation of Their Implementation on Laptop 4090
- Ours — Evaluation of Our Implementation on Laptop 4090

Setting	Methods	Track Time (s/frame) ↓	Map Time (s/frame) ↓	Total Time (s/frame) ↓	Num Gaussians ↓	ATE RMSE (cm) ↓	PSNR (db) ↑	Depth L1 (cm) ↓
base	reported	1.00	1.44	-	-	0.27	32.81	0.49
	reproduced	2.74	4.94	7.85	5,085,417	0.32	32.48	0.51
	ours	0.32	0.59	0.93	973,059	0.05	35.78	0.25
small	reported	0.19	0.33	-	-	0.39	-	-
	reproduced	0.27	0.45	0.84	931,214	0.52	29.29	0.83
	ours	0.08	0.14	0.24	1,101,708	0.28	30.44	0.55
tiny	reported	-	-	-	-	-	-	-
	reproduced	0.10	0.17	0.39	880,241	6.40	22.97	4.31
	ours	0.03	0.05	0.10	954,972	0.26	22.92	3.28

M | ROBOTICS

Results: Replica Dataset

1. Reported (3080 Ti) -> Reproduced (Laptop 4090) is 1.3 to 3.4 slower
2. Reproduced (SplaTAM) -> Ours (gsplatam) is 3 to 8 times faster

Setting	Methods	Track Time (s/frame) ↓	Map Time (s/frame) ↓	Total Time (s/frame) ↓	Num Gaussians ↓	ATE RMSE (cm) ↓	PSNR (db) ↑	Depth L1 (cm) ↓
base	reported	1.00	1.44	-	-	0.27	32.81	0.49
	reproduced	2.74	4.94	7.85	5,085,417	0.32	32.48	0.51
	ours	0.32	0.59	0.93	973,059	0.05	35.78	0.25
small	reported	0.19	0.33	-	-	0.39	-	-
	reproduced	0.27	0.45	0.84	931,214	0.52	29.29	0.83
	ours	0.08	0.14	0.24	1,101,708	0.28	30.44	0.55
tiny	reported	-	-	-	-	-	-	-
	reproduced	0.10	0.17	0.39	880,241	6.40	22.97	4.31
	ours	0.03	0.05	0.10	954,972	0.26	22.92	3.28

M | ROBOTICS

Results: Replica Dataset

1. Reproduced results match reported results within a margin
2. Our tracking is significantly better across all settings
3. Our mapping is comparable for tiny/small and superior for base

Setting	Methods	Track Time (s/frame) ↓	Map Time (s/frame) ↓	Total Time (s/frame) ↓	Num Gaussians ↓	ATE RMSE (cm) ↓	PSNR (db) ↑	Depth L1 (cm) ↓
base	reported	1.00	1.44	-	-	0.27	32.81	0.49
	reproduced	2.74	4.94	7.85	5,085,417	0.32	32.48	0.51
	ours	0.32	0.59	0.93	973,059	0.05	35.78	0.25
small	reported	0.19	0.33	-	-	0.39	-	-
	reproduced	0.27	0.45	0.84	931,214	0.52	29.29	0.83
	ours	0.08	0.14	0.24	1,101,708	0.28	30.44	0.55
tiny	reported	-	-	-	-	-	-	-
	reproduced	0.10	0.17	0.39	880,241	6.40	22.97	4.31
	ours	0.03	0.05	0.10	954,972	0.26	22.92	3.28

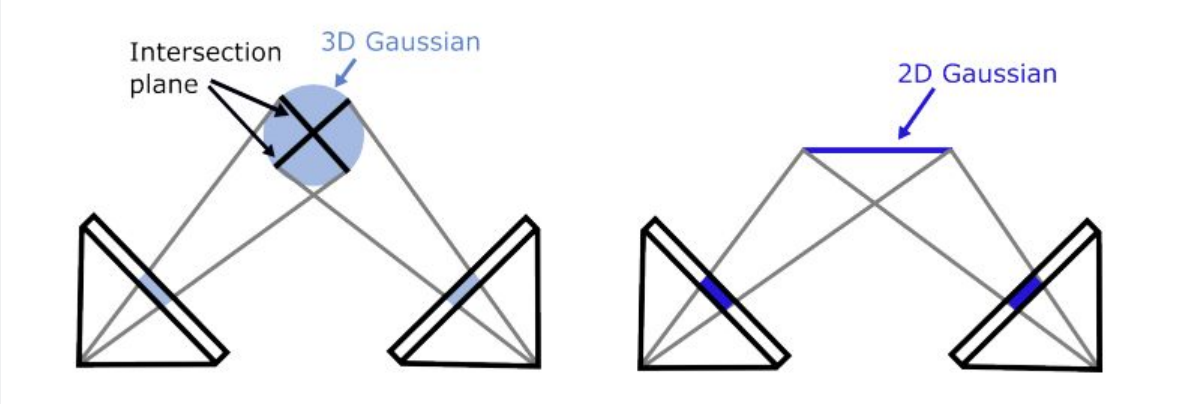
M | ROBOTICS

Method: Geometrically Accurate Gaussians

3DGS provides smooth photometric loss

2DGS is more geometrically accurate

- Camera pose gradients were not implemented, so we implemented it



Huang et al. 2DGS: 2D Gaussian Splatting for Geometrically Accurate Radiance Fields (SIGGRAPH 2024)

Results: Geometrically Accurate Gaussians

- 2DGS is slightly better for 3x runtime

- Isotropic gaussians are slightly better with identical runtime

Type	Covariance	Track Time (s/frame) ↓	Map Time (s/frame) ↓	Total Time (s/frame) ↓	Num Gaussians ↓	ATE RMSE (cm) ↓	PSNR (db) ↑	Depth L1 (cm) ↓
3D	Isotropic	0.03	0.05	0.10	984,531	0.26	23.17	2.58
3D	Anisotropic	0.03	0.05	0.10	954,972	0.26	22.92	3.28
2D	Isotropic	0.12	0.16	0.30	1,193,273	0.60	23.66	2.33
2D	Anisotropic	0.11	0.16	0.29	1,171,766	0.60	23.11	2.74

M | ROBOTICS

Limitation and Future Work

Loss of tracking is the biggest issue on realistic datasets

- 3DGS excel at local optimization
- 3DGS bad at larger camera movement / motion blur

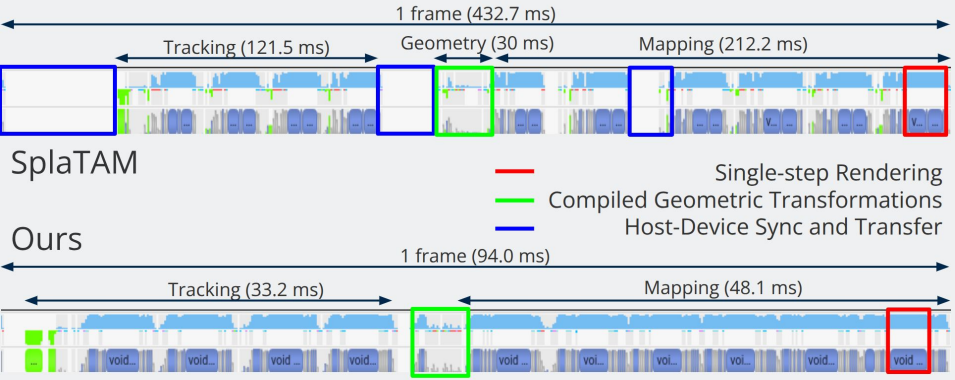
Next Steps

- Integrate Sparse Keypoints such as SIFT / ORB
- Backend for robustness and recovery

M | ROBOTICS

Summary

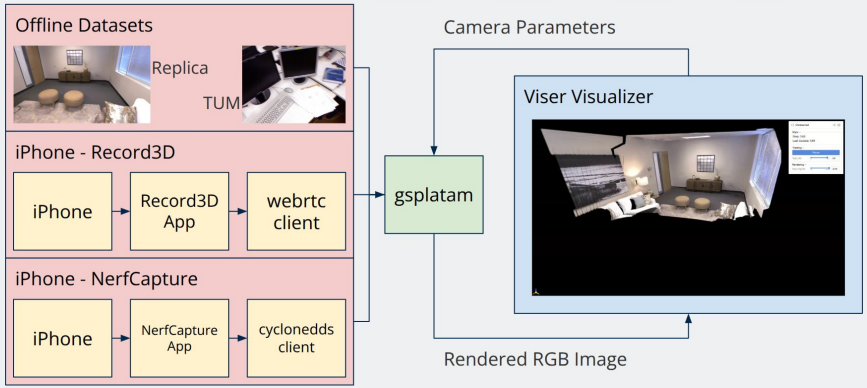
Method: Runtime Optimization



gsplat: An Open-Source Library for Gaussian Splatting (arXiv 2024)
NVIDIA Nsight Systems. https://developer.nvidia.com/nsight-systems.

M | ROBOTICS

Method: Visualization



Nerf Studio Team. Viser: a Library for Interactive 3D Visualization in Python. (Github 2023)

M | ROBOTICS

Integration with gsplat
10-15 fps on a Laptop

Interactive Visualization
iPhone Streaming over WIFI

M | ROBOTICS