浙江大學
ZHEJIANG UNIVERSITY

基于2DGS的表面重建

小组：022

杨亿酬 韩泰睿

Dec.22, 2025

目　录

CONTENTS

1 原　理　回　顾
Basic Principle Review

2 基　本　实　现
Basic Implementation

3 进　阶　探　索
In-depth Exploration

4 结　果　呈　现
Result

5 Q & A
Question & Answer

原理回顾

Basic Principle Review

1 原理回顾 / *2D Gaussian Splatting*[1]

[Problem] 3DGS fails to represent surface due to multi-view inconsistency

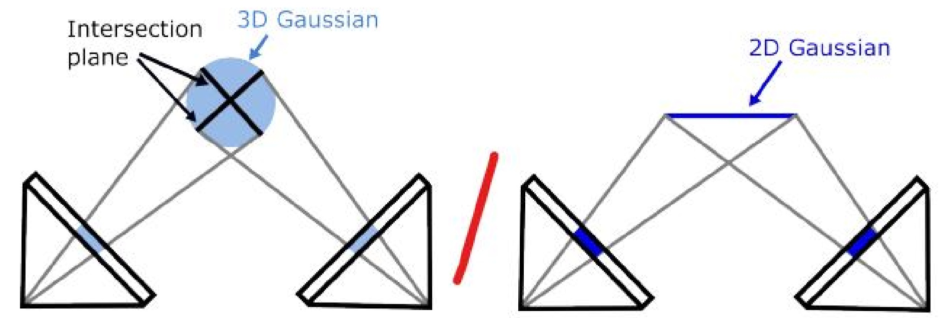


Fig. 2. Comparison of 3DGS and 2DGS. 3DGS utilizes different intersection planes for value evaluation when viewing from different viewpoints, resulting in inconsistency. Our 2DGS provides multi-view consistent value evaluations.

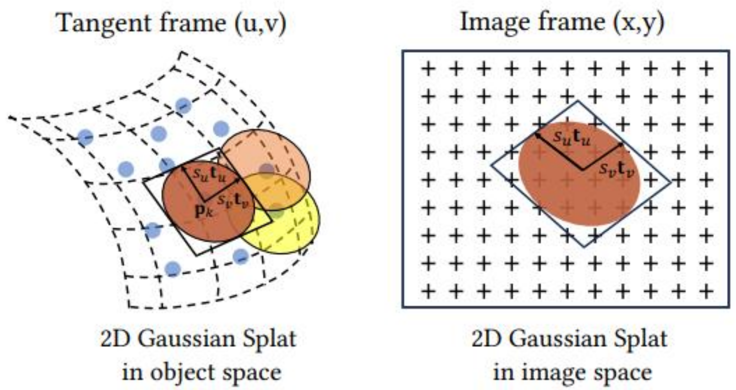


Fig. 3. Illustration of 2D Gaussian Splatting. 2D Gaussian Splats are elliptical disks characterized by a center point $\mathbf{p}_k$, tangential vectors $\mathbf{t}_u$ and $\mathbf{t}_v$, and two scaling factors (s_u and s_v) control the variance. Their elliptical projections are sampled through the ray-splat intersection (Section 4.2) and accumulated via alpha-blending in image space. 2DGS reconstructs surface attributes such as colors, depths, and normals through gradient descent.

[Solution] 2DGS:collapse the 3D volume into a set of 2D oriented planar Gaussian disks

原 来 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

基本实现

Basic Implementation

2 基本实现 / *data collection*

2 基本实现 / *preprocess*

Segment Anything Model(SAM)[2]

fig3.Image/Video segmentation on *https://segment-anything.com/*

浙江大学 ZHEJIANG UNIVERSITY

原 来 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

2基本实现 / *working pipeline*

1.input and initialization
2.tangent-plane parameterization(disk coordinate,opacity and color)
3.transformation to camera space(transformation matrix)
4.perspective-correct ray-splat intersection(compute intersacts)
5.filtering and stability
6.alpha decomposition(color accumulation)
7.differentiable optimization(update disk parameters)
8.output → real-time rendering and geometry extraction

hint:
bounded-mesh for indoor object reconstruction
depth_trunc:define the max effective distance

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

进阶探索

In-depth Exploration

浙江大学
ZHEJIANG UNIVERSITY

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

3 进阶探索 / PGSR[3]

[Problem] 2DGS doesn’t perform well on texture-weak objects/background

Reason:2D Gaussian disk hardly finds the visual features of texture-weak areas(depth,colors,corners,etc)→floating disks

Solution:PGSR(Planar-based Gaussian Splatting Reconstruction)
1.planar constraint 3DGS(loss function for the deviation between principal axis and normal direction)→fit to the local plane
2.unbiased depth rendering(accurate distance measurement)
3.multi-view regularization

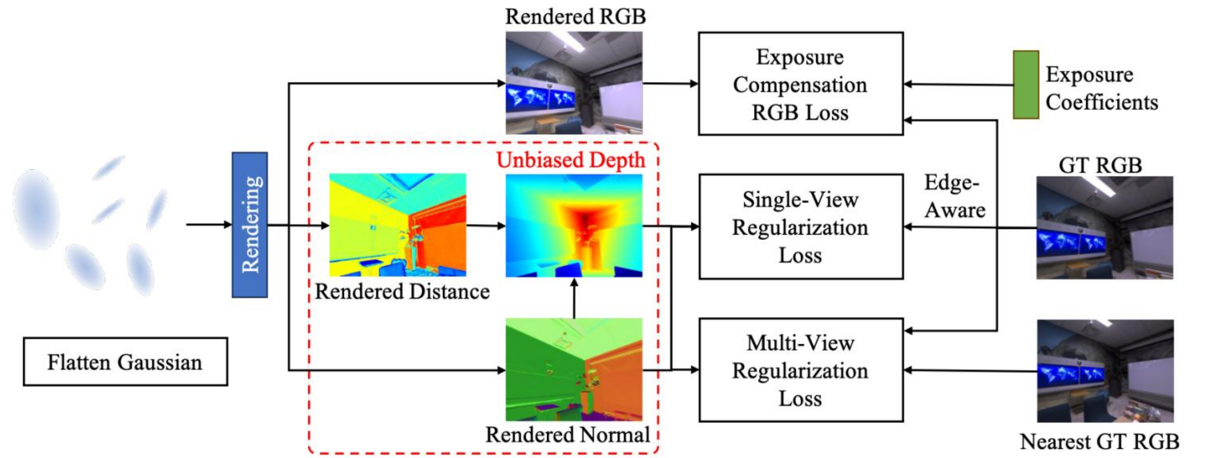


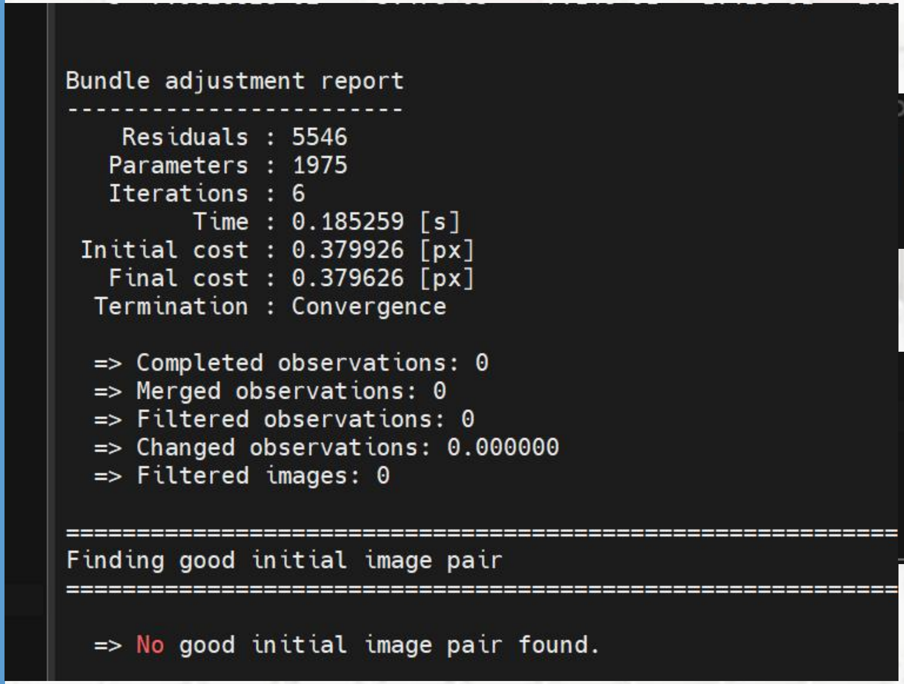
Fig. 4: **PGSR Overview.** We compress Gaussians into flat planes and render distance and normal maps, which are then transformed into unbiased depth maps. Single-view and multi-view geometric regularization ensure high precision in global geometry. Exposure compensation RGB loss enhances reconstruction accuracy.

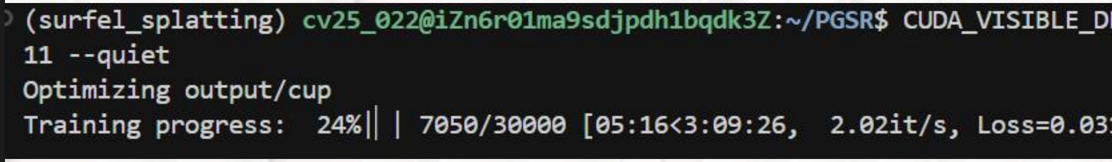
3 进阶探索 / *Sparse2DGS*[4]

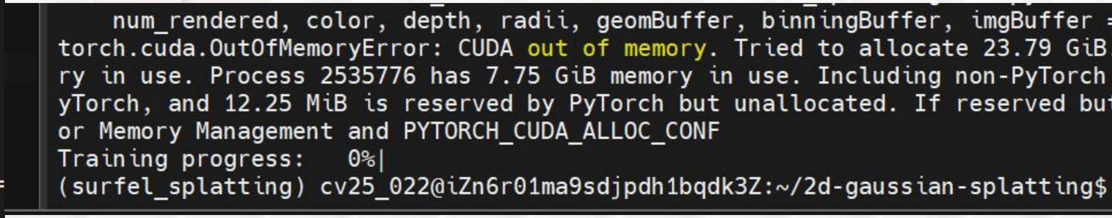
[Problem] PGSR (as well as 2DGS) can be too slow and /space-consuming

Solution:reduce the number of input images while maintaining the reconstruction quality

Sparse2DGS:MVS-initialized Gaussian Splatting pipeline
MVS estimates depth map through cross-view matching(CLMVSNet[5])







浙江大学
ZHEJIANG UNIVERSITY

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

结果呈现

Result

浙江大学 ZHEJIANG UNIVERSITY

原 理 回 顾

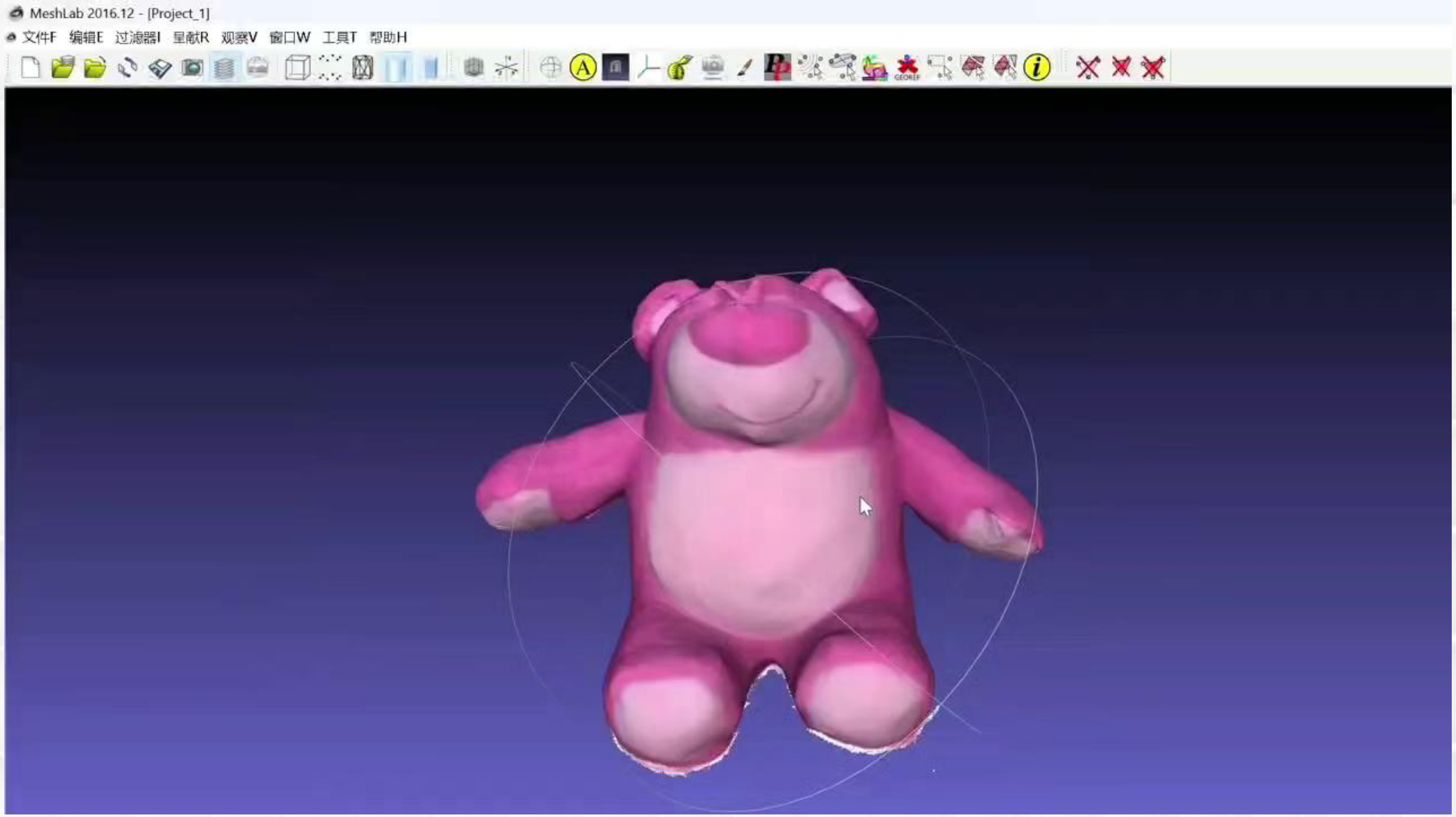
基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / *Lotso on 2DGS*



Lotso on 2DGS

ZHEJIANG UNIVERSITY

原 理 回 顾

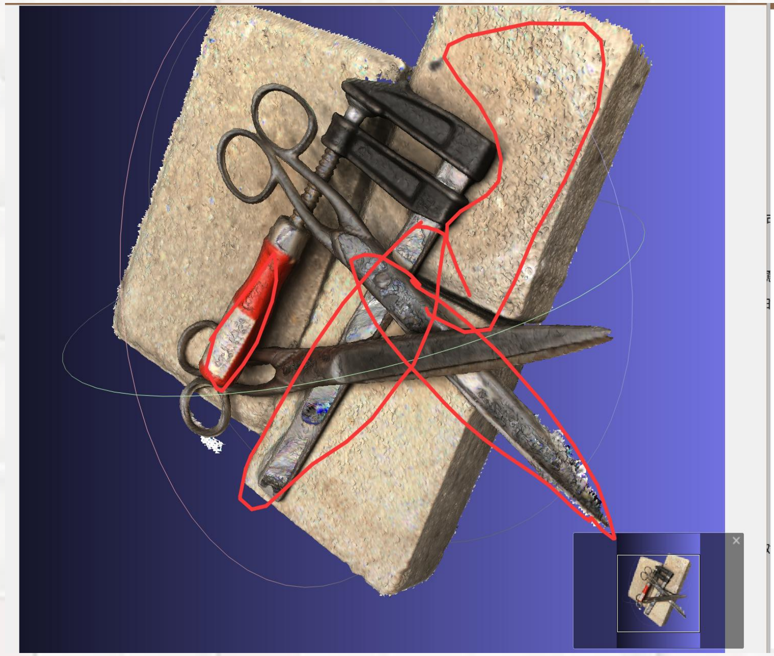
基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / *DTU dataset*（scan37）



2DGS

PGSR

comparison between 2DGS and PGSR

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / lotso

2DGS重建结果：细节较少

PGSR重建结果：细节褶皱增多

浙江大学 ZHEJIANG UNIVERSITY

原 理 回 顾

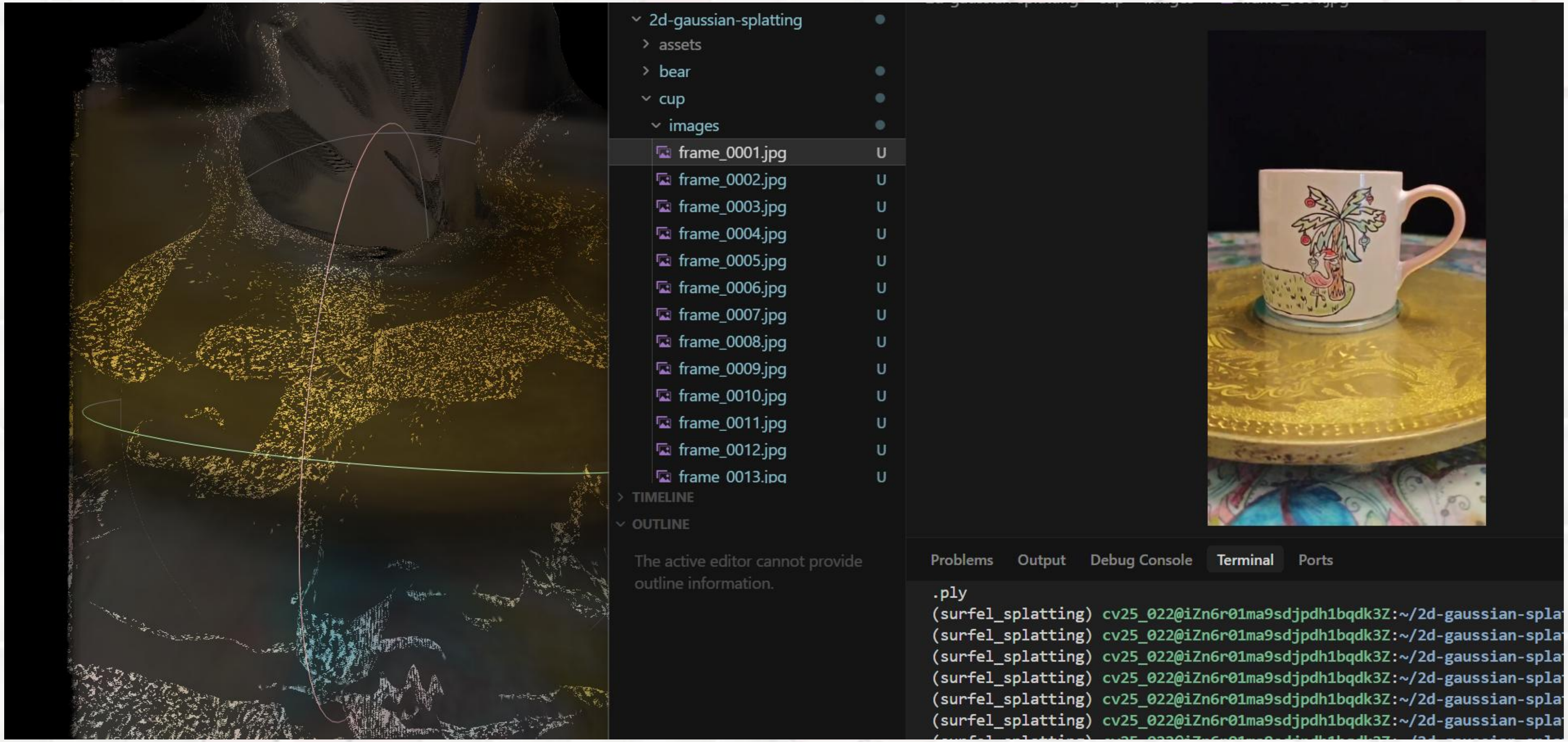
基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / *Texture-weak demo:mug*



raw-input on 2DGS

浙江大学 ZHEJIANG UNIVERSITY

原 理 回 顾

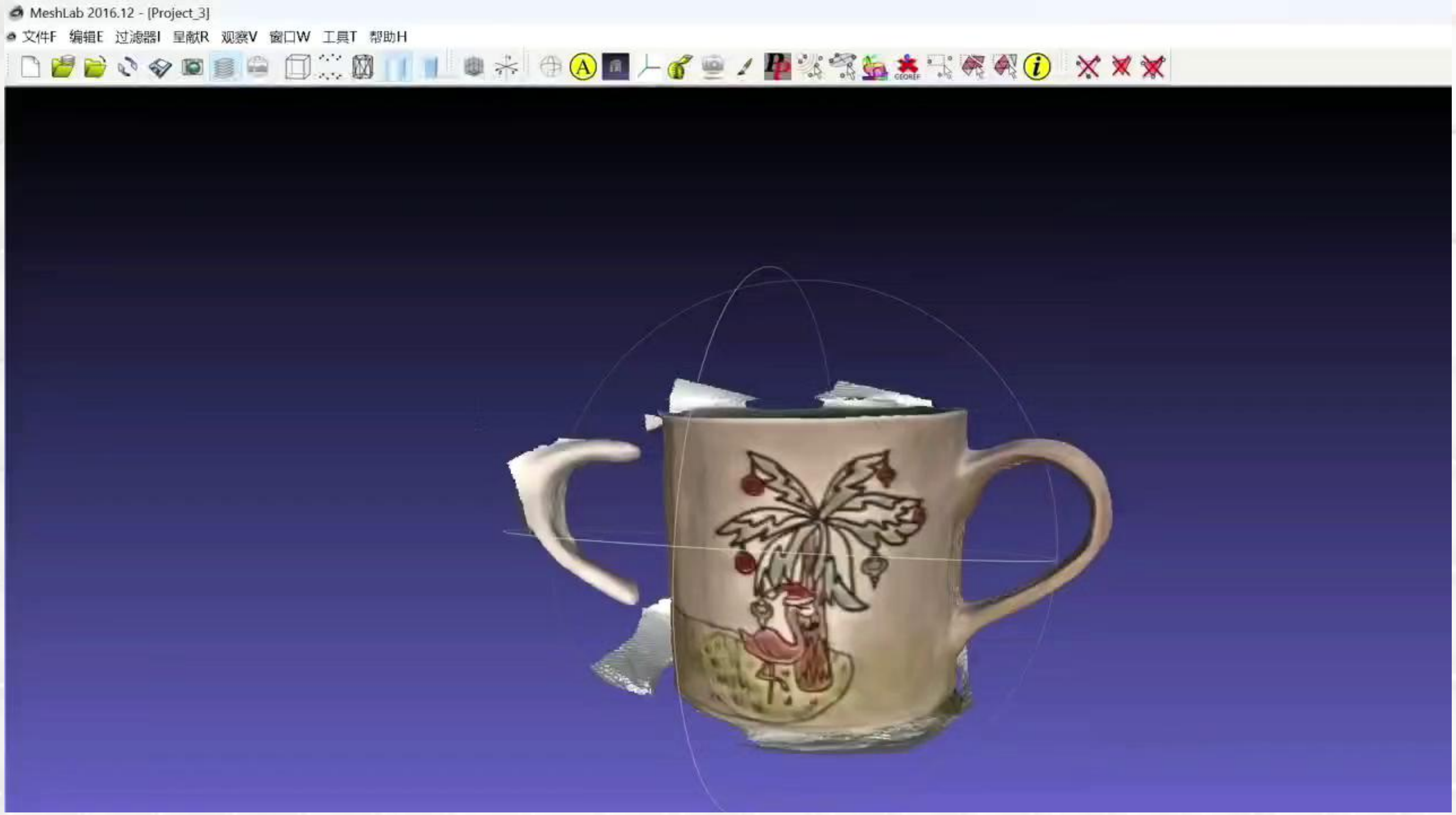
基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / *Texture-weak demo:mug*



weak-texture mug on PGSR

原 理 回 顾

基 本 实 现

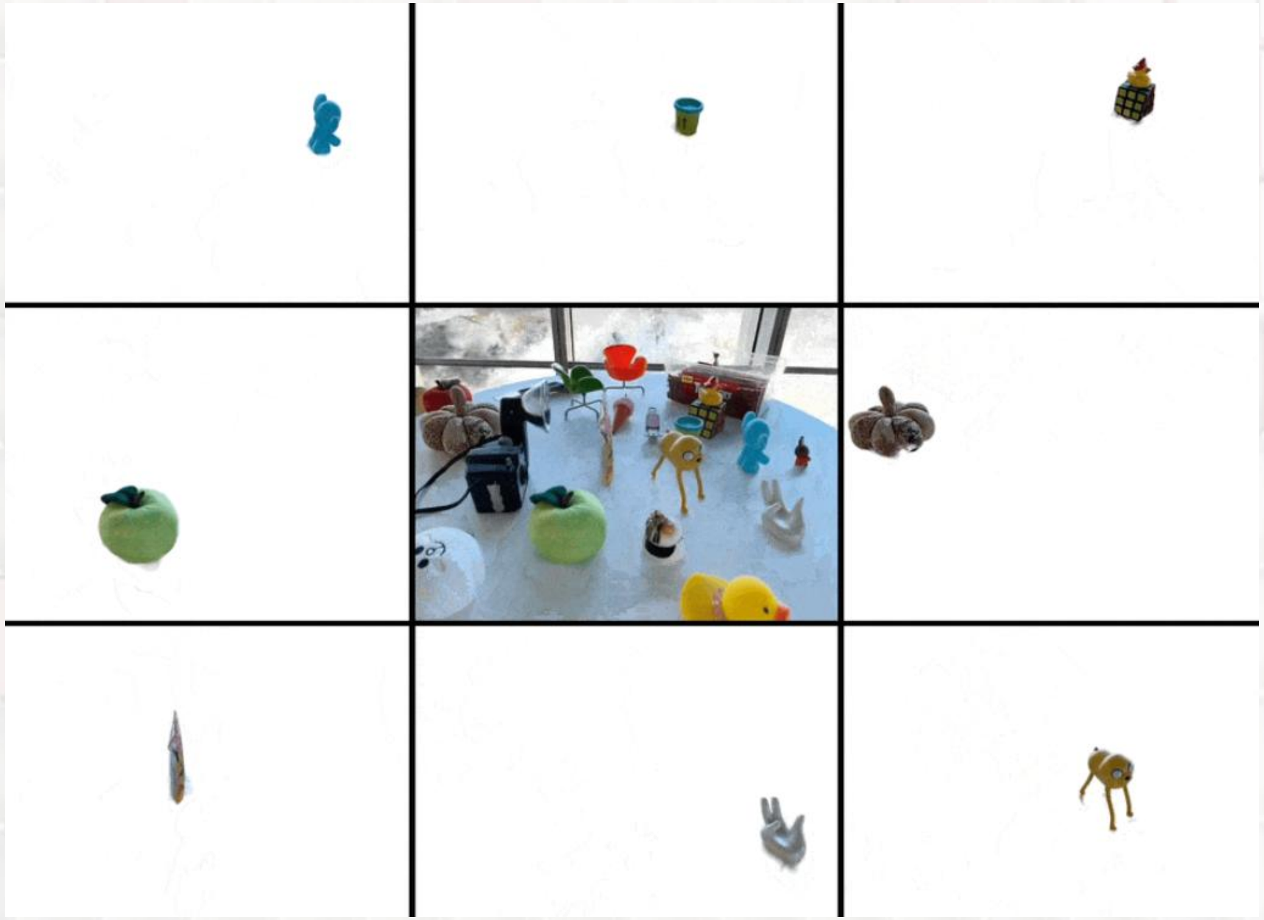
进 阶 探 索

结 果 呈 现

Q & A

4 结果呈现 / *postprocess*

SAGA:Segment Any 3D Gaussians[6]
SAM→2D mask→3D point cloud
very fast(~ms)



浙江大学
ZHEJIANG UNIVERSITY

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

Reference:

[1]2D Gaussian Splatting for Geometrically Accurate Radiance Fields, Huang, Binbin and Yu, Zehao and Chen, Anpei and Geiger, Andreas and Gao, Shenghua, Association for Computing Machinery, SIGGRAPH 2024 Conference Papers, 2024,10.1145/3641519.3657428

[2]Segment Anything, Alexander Kirillov and Eric Mintun and Nikhila Ravi and Hanzi Mao and Chloe Rolland and Laura Gustafson and Tete Xiao and Spencer Whitehead and Alexander C. Berg and Wan-Yen Lo and Piotr Dollár and Ross Girshick, 2023, arXiv preprint arXiv:2304.02643

[3]PGSR: Planar-based Gaussian Splatting for Efficient and High-Fidelity Surface Reconstruction, Chen, Danpeng and Li, Hai and Ye, Weicai and Wang, Yifan and Xie, Weijian and Zhai, Shangjin and Wang, Nan and Liu, Haomin and Bao, Hujun and Zhang, Guofeng, arXiv preprint arXiv:2406.06521, 2024

[4]Sparse2DGS: Geometry-Prioritized Gaussian Splatting for Surface Reconstruction from Sparse Views, Wu, Jiang and Li, Rui and Zhu, Yu and Guo, Rong and Sun, Jinqiu and Zhang, Yanning, arXiv preprint arXiv:2504.20378, 2025

[5]Kaiqiang Xiong, Rui Peng, Zhe Zhang, Tianxing Feng, Jianbo Jiao, Feng Gao, and Ronggang Wang. Cl-mvsnet:Unsupervised multi-view stereo with dual-level contrastive learning. In Proceedings of the IEEE/CVF International Conference on Computer Vision, pages 3769–3780, 2023. 1, 2, 3, 4, 6, 7

[6]Segment Any 3D Gaussians, Jiazhong Cen and Jiemin Fang and Chen Yang and Lingxi Xie and Xiaopeng Zhang and Wei Shen and Qi Tian, 2023, arXiv preprint arXiv:2312.00860

原 理 回 顾

基 本 实 现

进 阶 探 索

结 果 呈 现

Q & A

5

Questions?