Tetrahedron Splatting for 3D Generation

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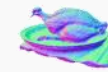
https://fudan-zvg.github.io/tet-splatting/
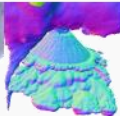

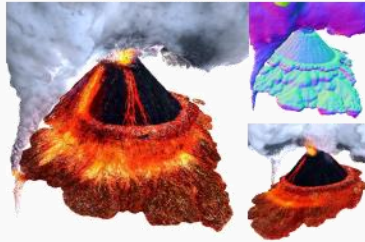"a DSLR photo of the Imperial State Crown of England"
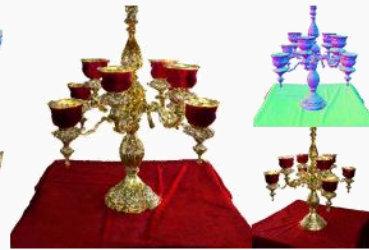
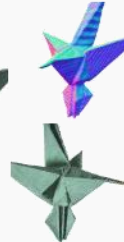"a DSLR photo of a candelabra with many candles on a red velvet tablecloth"
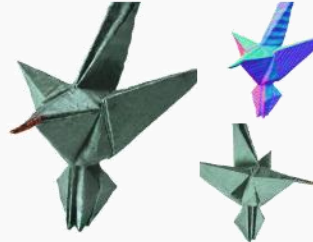
"a DSLR photo of a roast turkey on a platter"

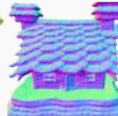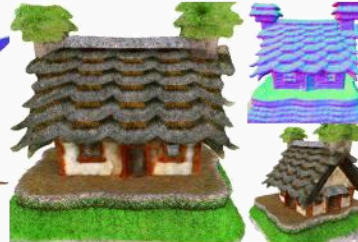"a DSLR photo of a steaming basket full of dumplings"

"an erupting volcano, aerial view"

"a zoomed out DSLR photo of an origami crane"

"a zoomed out DSLR photo of a 3d model of an adorable cottage with a thatched roof"

"Wedding dress made of tentacles"

"a zoomed out DSLR photo of a recliner chair" "a bald eagle carved out of wood"

"a DSLR photo of a pigeon reading a book"

"a ceramic lion"

Previous 3D representations

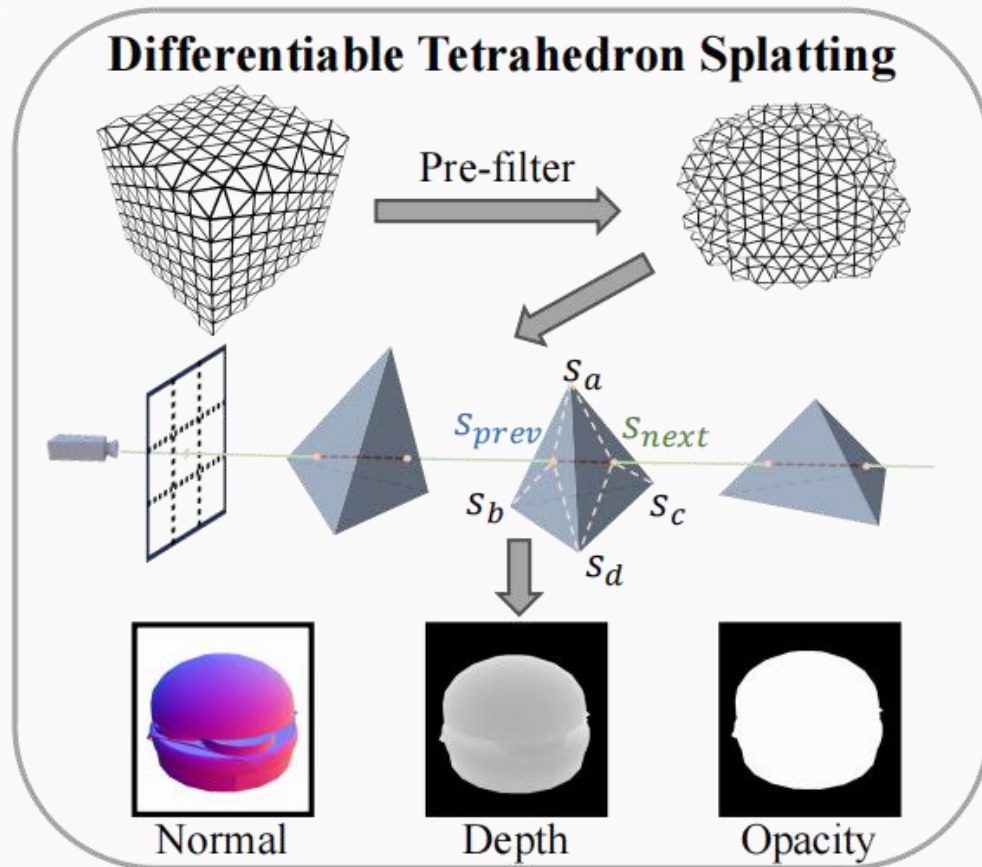We introduce, Tetrahedron Splatting (TeT-Splatting), that supports

1. Easy convergence during optimization

2. Precise mesh extraction

3. Real-time rendering

Table 1: Comparison of different representations for 3D generation.

Representation	NeRF [28]	3DGS [13]	DMTet [40]	TeT-Splatting (Ours)
Precise mesh extraction			✓	✓
Easy convergence	✓	✓		✓
Real-time rendering		✓	✓	✓
Representative method	DreamFusion [32], Magic3D [18]	DreamGaussion [46], GSGEN [5]	Fantasia3D [3], RichDreamer [34]	Ours

Method

Tetrahedron Splatting

Differentiable Tetrahedron Splatting

Pre-filter

S_a

S_{prev} S_{next}

S_b S_c

S_d

Normal   Depth   Opacity

TeT-Splatting

1. Pre-filter nearly transparent tetrahedra
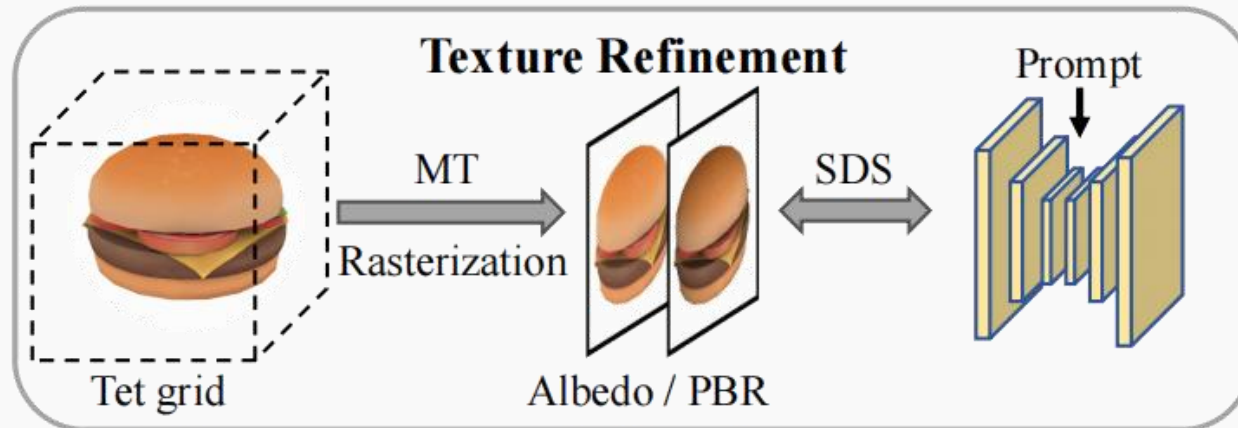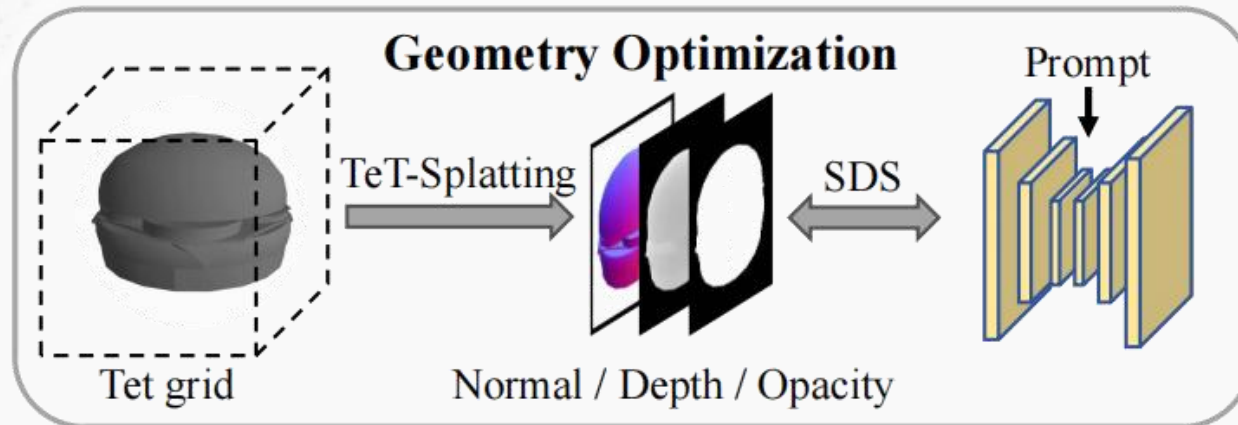
2. Cauculate the opacity of each tetrahedron

$$\alpha = \max\left(\frac{\Phi_s(f_{\text{prev}}) - \Phi_s(f_{\text{next}})}{\Phi_s(f_{\text{prev}})}, 0\right)$$

3. Alpha-blending

$$\{\mathcal{N}, \mathcal{D}, \mathcal{O}\} = \sum_{i \in N} T_i \alpha_i \{\boldsymbol{n}_i, \boldsymbol{z}_i, 1\}, \quad T_i = \prod_{j=1}^{i-1}(1 - \alpha_j),$$
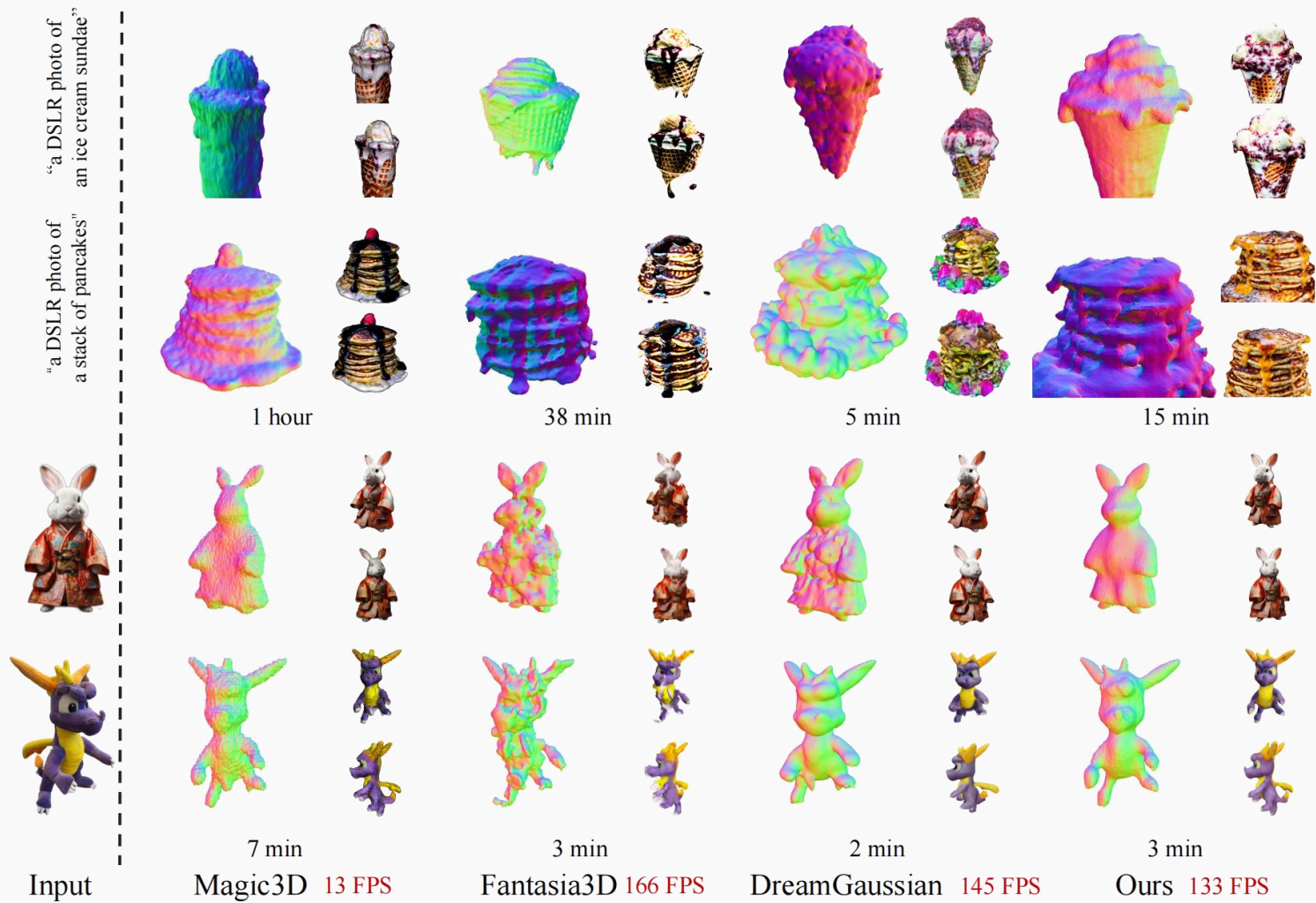
Method

Tetrahedron Splatting for 3D generation

1. Get detailed geometry with TeT-Splatting using SDS loss

2. Transition to polygonal mesh through Marching Tetrahedra

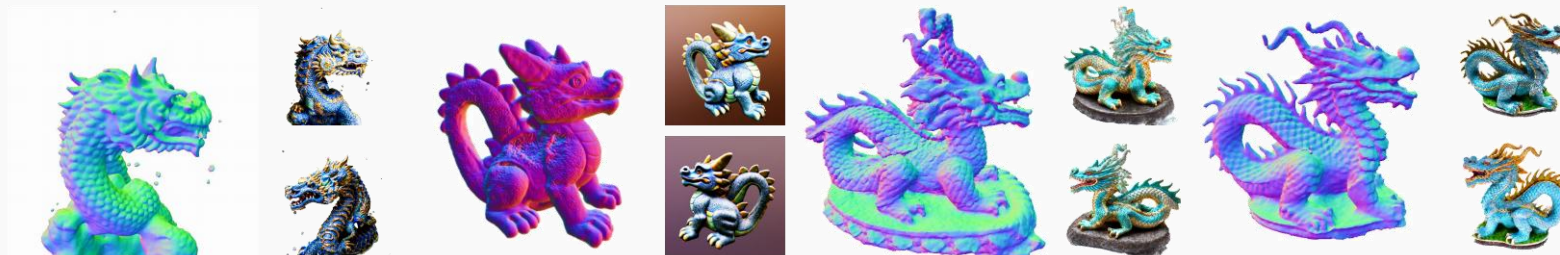3. Get detailed texture with rasterization using SDS loss

Experiment

Vanilla RGB-based diffusion priors

Experiment

Rich diffusion priors

"a DSLR photo of a porcelain dragon"

"a DSLR photo of a cup full of pens and pencils"

"a DSLR photo of a turtle standing on its hind legs, wearing a top hat"

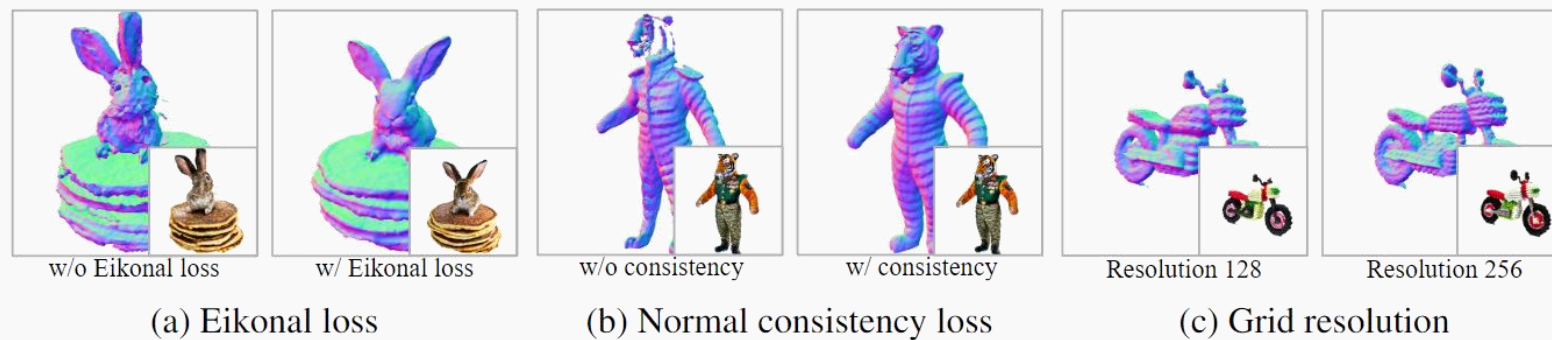| 11 hours | 1 hour | 2 hours | 1.5 hours |
| ProlificDreamer | MVDream | RichDreamer | Ours |

Experiment

Mesh exportation

Input | Before ... After (Magic3D) | Before ... After (DreamGaussian) | Before ... After (Ours)

Ablation studies

(a) Eikonal loss — w/o Eikonal loss, w/ Eikonal loss

(b) Normal consistency loss — w/o consistency, w/ consistency

(c) Grid resolution — Resolution 128, Resolution 256

Experiment

Quantitative CLIP score Comparison

	Prolificdreamer [51]	MVDream [42]	RichDreamer [34]	RichDreamer [34]	Ours
Geometry CLIP score ↑	23.3818*	24.8003*	25.8820*	23.0143	**23.1641**
Appearance CLIP score ↑	31.8022*	28.7331*	31.7099*	29.2198	**29.4197**

Results marked with "*" are taken from RichDreamer.
Since RichDreamer did not release their prompt list (113 objects), we use our own prompt list (183 objects) for evaluation.
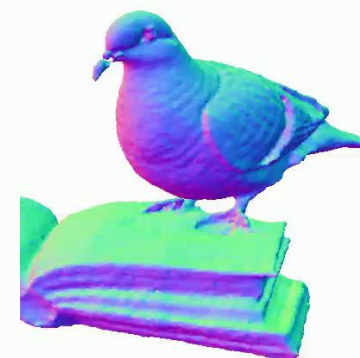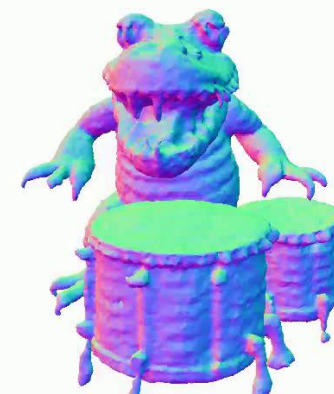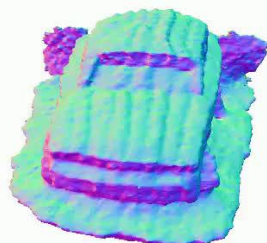
Experiment

Generated 3D assets
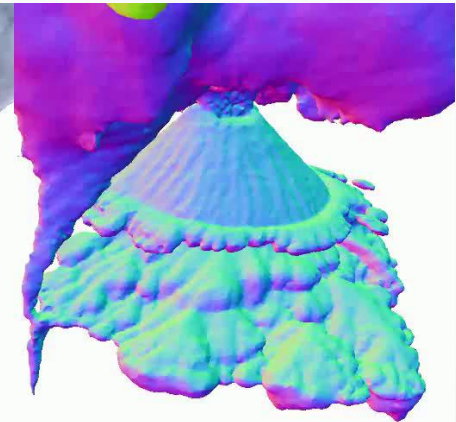
Experiment

Generated 3D assets

Experiment

Generated 3D assets

THANK YOU

Project page