MiraGe: Editable 2D Images using Gaussian Splatting

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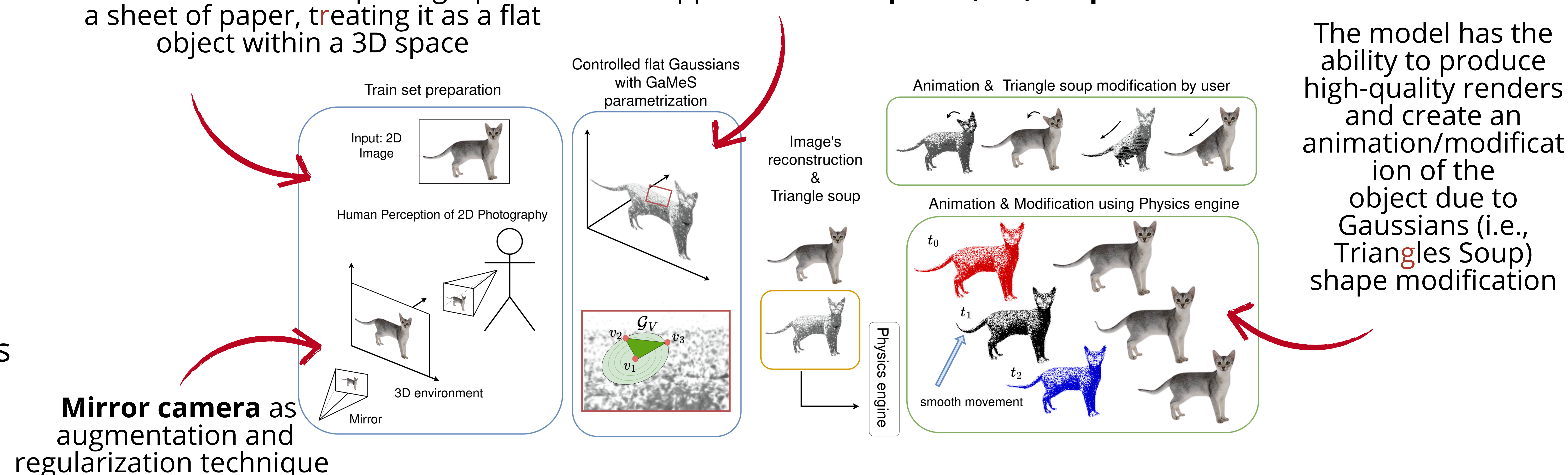
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TL;DR

- **MiraGe** encodes 2D images by simulating **human perception.**

- **Flat 3D Gaussian components** achieves state-of-the-art reconstruction quality.

- Manipulation of 2D images within 3D space, creating the **illusion of 3D effects.**

- **Integration with physics engine,** enabling physics-based modifications and interactions for both 2D and 3D environments.
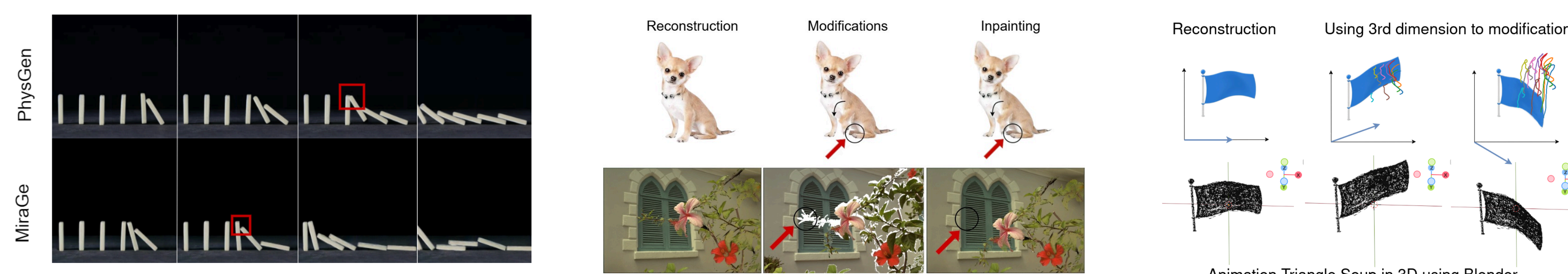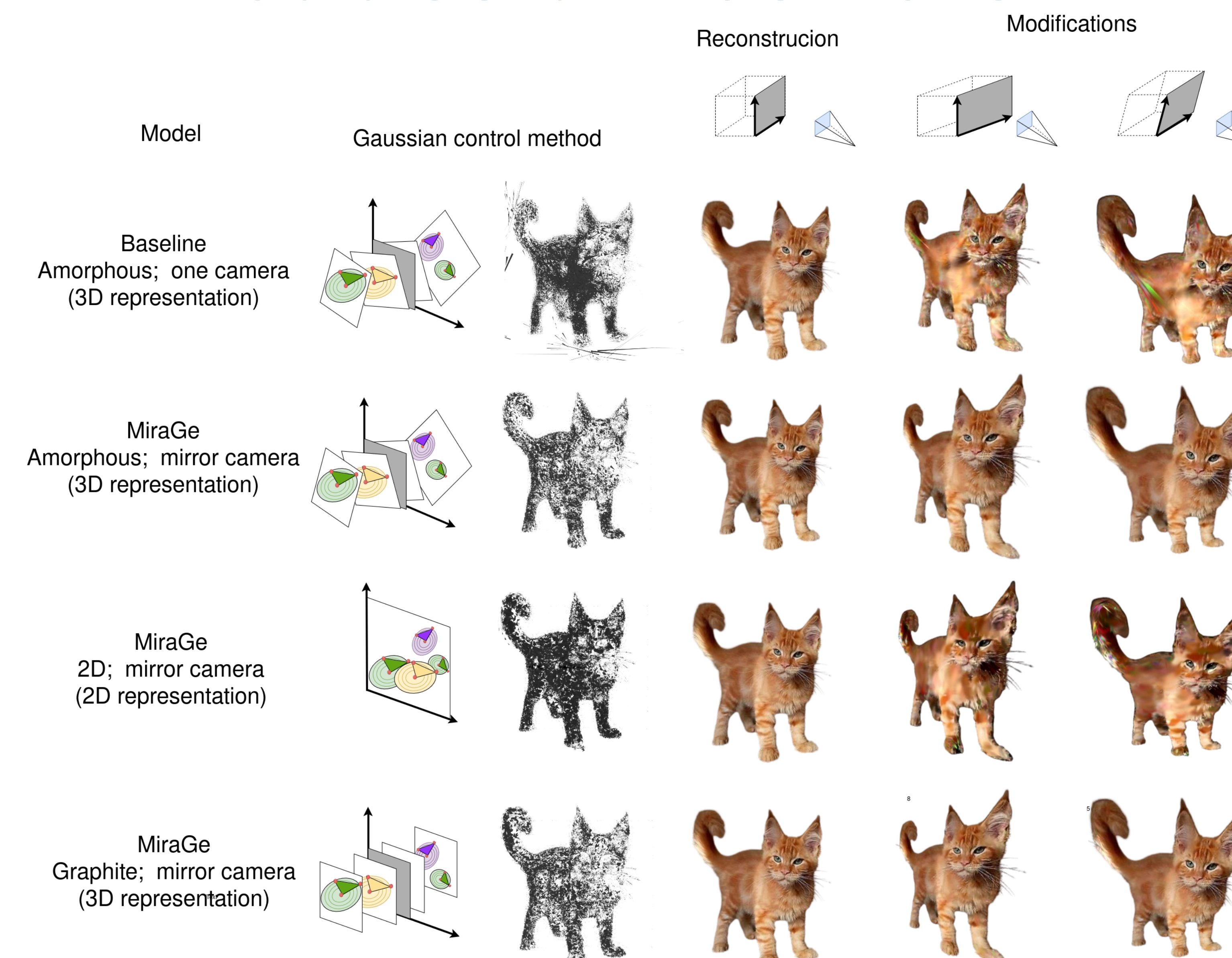
Modifications

- Integrating physical engines with 2D images
- Editing 2D images directly within a 3D space
- Enabling complex nonlinear modifications of 2D images

MiraGe perceives a 2D image as a human would view a photograph or a sheet of paper, treating it as a flat object within a 3D space

Mirror camera as augmentation and regularization technique

How to control Gaussians? Three approches: **Amorphous, 2D, Graphite**

Train set preparation

Input: 2D Image

Human Perception of 2D Photography

3D environment

Mirror

Controlled flat Gaussians with GaMeS parametrization

Image's reconstruction & Triangle soup

$\mathcal{G}_V$
v_2 v_3
v_1

Physics engine

Animation & Triangle soup modification by user

Animation & Modification using Physics engine

t_0

t_1

t_2

smooth movement

The model has the ability to produce high-quality renders and create an animation/modification of the object due to Gaussians (i.e., Triangles Soup) shape modification

Three approaches for Gaussian control

Reconstrucion   Modifications

Model   Gaussian control method

Baseline
Amorphous; one camera
(3D representation)

MiraGe
Amorphous; mirror camera
(3D representation)

MiraGe
2D; mirror camera
(2D representation)

MiraGe
Graphite; mirror camera
(3D representation)

Reconstruction

Modification

scaling

GAUSSIAN SPLATTING

User-driven modification

3D

Physics applied soft body

PhysGen

MiraGe

Reconstruction   Modifications   Inpainting

Reconstruction   Using 3rd dimension to modification

Animation Triangle Soup in 3D using Blender

Reconstruction task

MiraGe is surpassing baselines in PSNR with only 5k iterations, while also having a shorter training time!

	Kodak dataset		DIV2K dataset	
	PSNR ↑	Train Time(s) ↑	PSNR ↑	Train Time(s) ↑
WIRE	41.47	14339	35.64	25684
SIREN	40.83	6582	39.08	15125
I-NGP	43.88	491	37.06	676
NeuRBF	43.78	992	38.60	1715
3DGS	43.69	340	39.36	481
GI-70K	44.08	107	39.53	121
GI-70K*	44.12	116	39.53	112
GI-100K*	38.93	126	41.48	120
Our-70K; 5k iter	49.07	57	44.37	75
Our-100K; 5k iter	51.04	59	46.23	79
Our-70K; 30k iter	57.41	547	53.22	789
Our-100K; 30k iter	59.52	560	54.54	946

Check Project Page