Optimizing 4D Gaussians for Dynamic Scene Video from Single Landscape Images

In-Hwan Jin*, **Haesoo Choo***, Seong-Hun Jeong

Heemoon Park, Junghwan Kim, Oh-joon Kwon, **Kyeongbo Kong** †

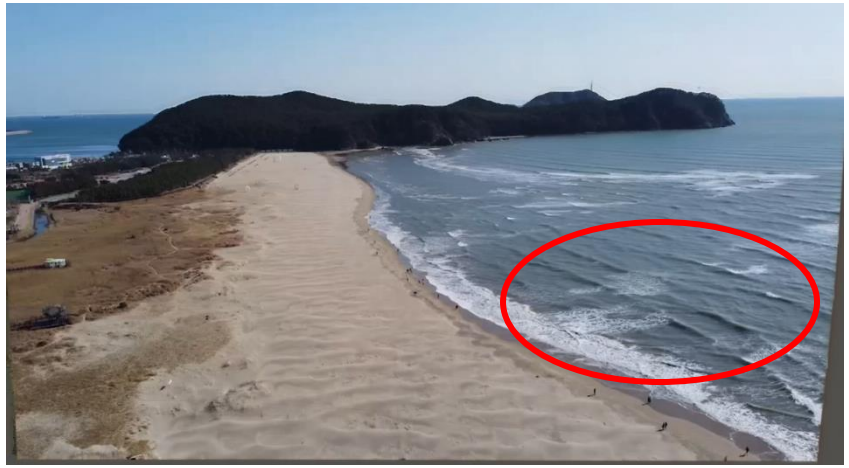
ICLR 2025

* Equal contribution
† Corresponding author

Related work

3D Cinemagraphy [1]

Dynamic Scene Video



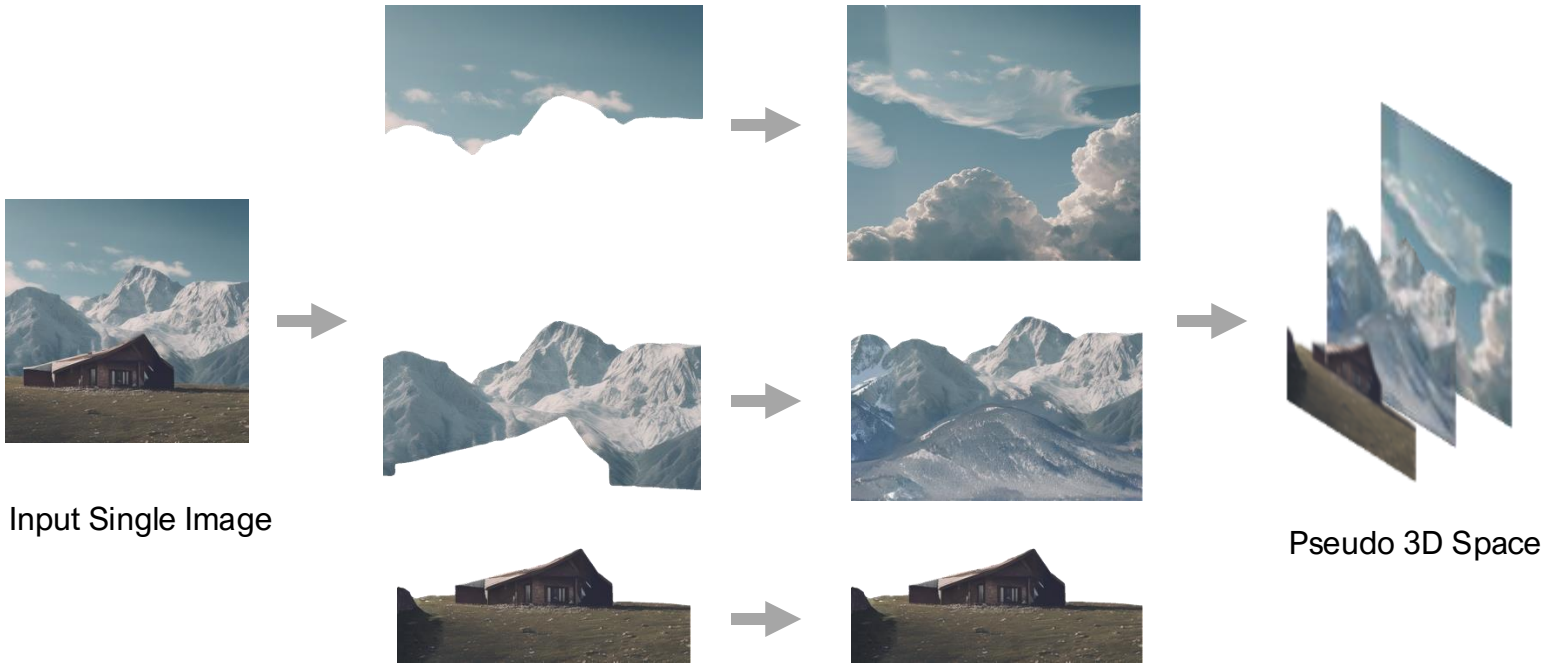
Input Single Image

Output Video

[1] 3D Cinemagraphy from a Single Image. *CVPR 2023*

Related work

3D Cinemagraphy [1], Make-it-4D [2]



[2] Make-It-4D: Synthesizing a Consistent Long-Term Dynamic Scene Video from a Single Image *ACM Multimedia 2023*

Related work

4D Gaussian Splatting [3,4]

[3] 4D Gaussian Splatting for Real-Time Dynamic Scene Rendering. *CVPR 2024*

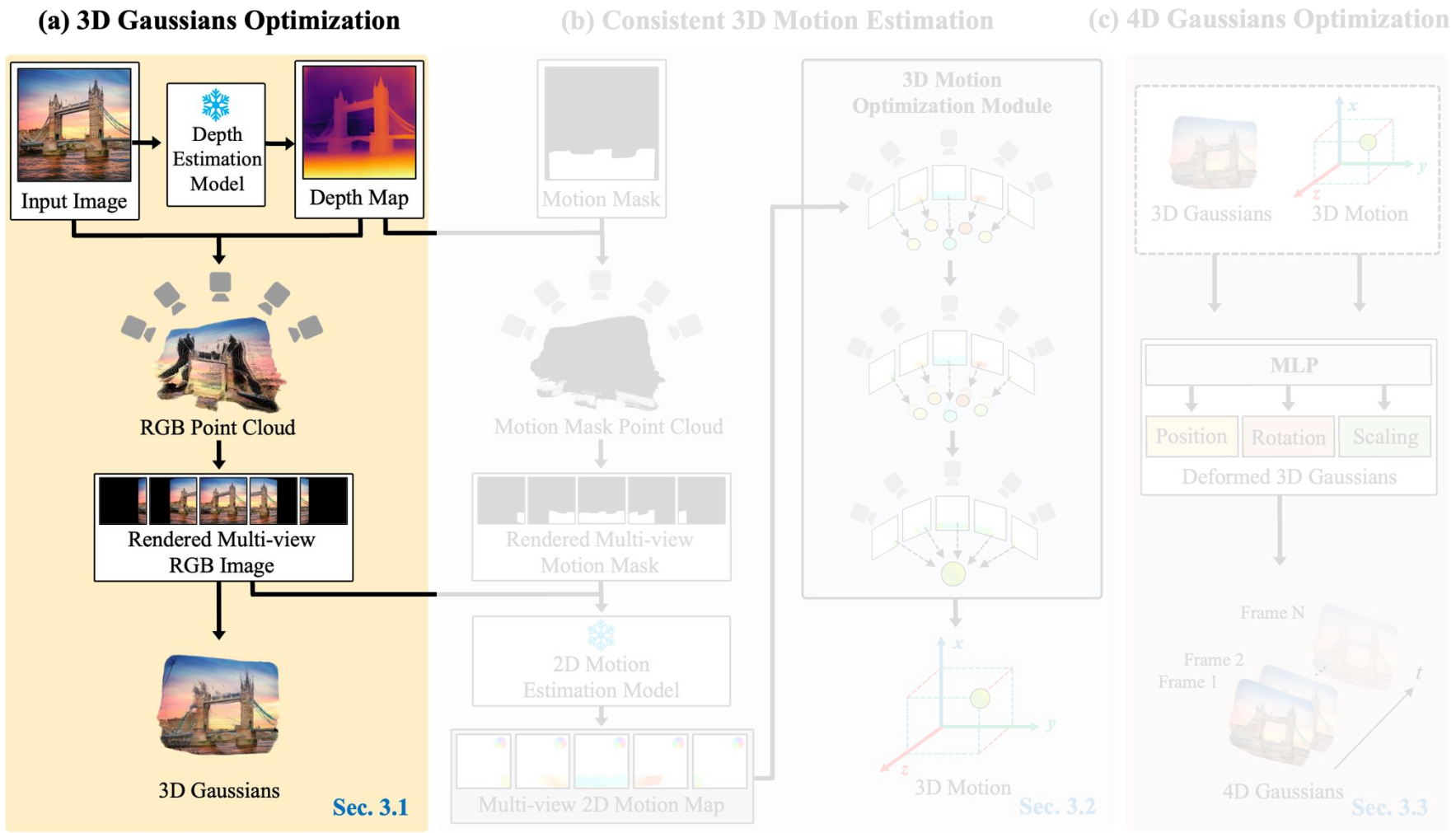
[4] Deformable 3D Gaussians for High-Fidelity Monocular Dynamic Scene Reconstruction. *CVPR 2024*

Challenges

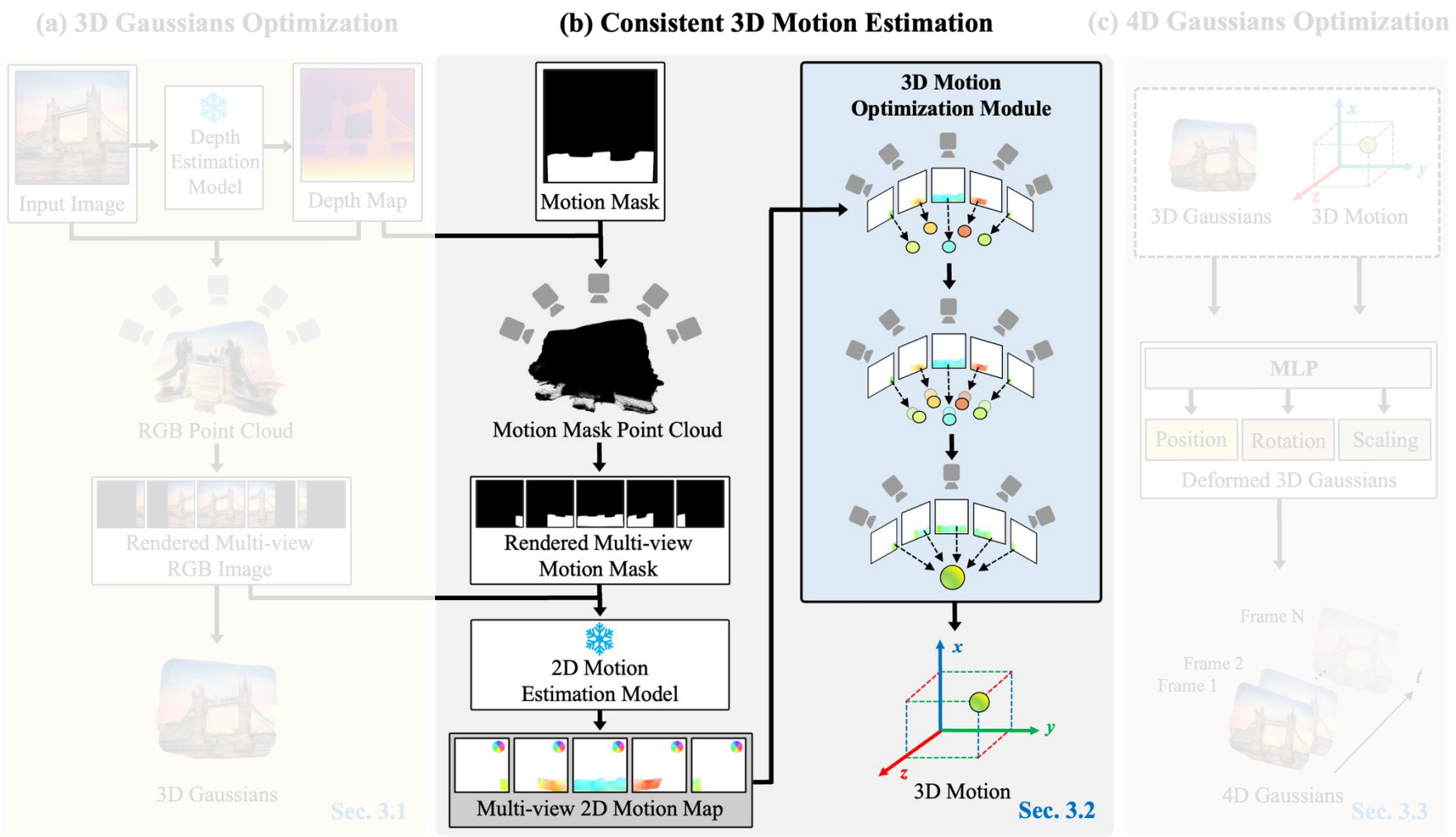
Single-image Animation

4D Reconstruction

Our Method

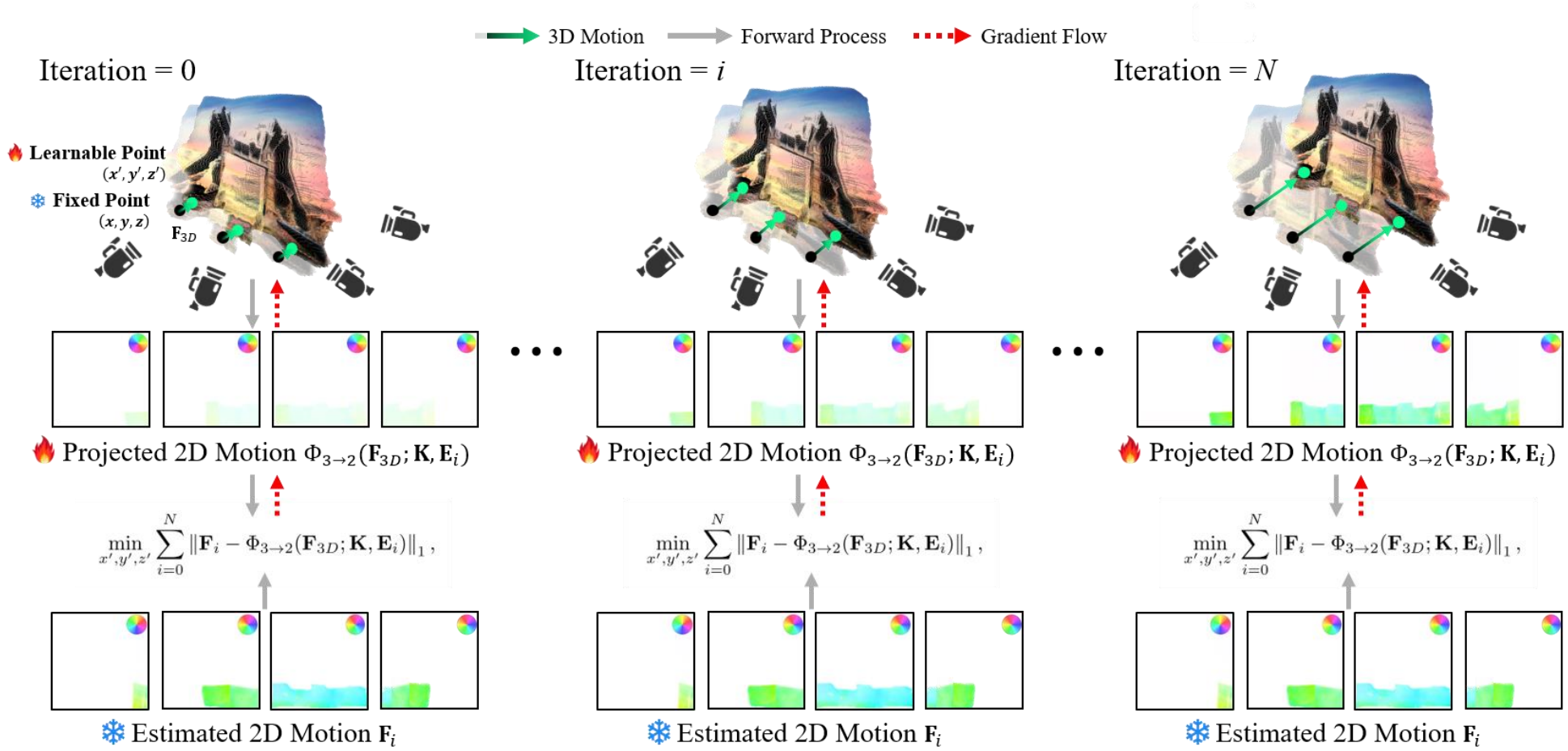

(a) 3D Gaussians Optimization
(b) Consistent 3D Motion Estimation
(c) 4D Gaussians Optimization
Input Image
Depth Estimation Model
Depth Map
RGB Point Cloud
Rendered Multi-view RGB Image
3D Gaussians
Sec. 3.1
Motion Mask
Motion Mask Point Cloud
Rendered Multi-view Motion Mask
2D Motion Estimation Model
Multi-view 2D Motion Map
3D Motion Optimization Module
3D Motion
Sec. 3.2
3D Gaussians
3D Motion
MLP
Position
Rotation
Scaling
Deformed 3D Gaussians
Frame N
Frame 2
Frame 1
4D Gaussians
Sec. 3.3

Our Method


(a) 3D Gaussians Optimization
(b) Consistent 3D Motion Estimation
(c) 4D Gaussians Optimization
Input Image
Depth Estimation Model
Depth Map
RGB Point Cloud
Rendered Multi-view RGB Image
3D Gaussians
Sec. 3.1
Motion Mask
Motion Mask Point Cloud
Rendered Multi-view Motion Mask
2D Motion Estimation Model
Multi-view 2D Motion Map
3D Motion Optimization Module
3D Motion
Sec. 3.2
3D Gaussians
3D Motion
MLP
Position
Rotation
Scaling
Deformed 3D Gaussians
Frame N
Frame 2
Frame 1
4D Gaussians
Sec. 3.3

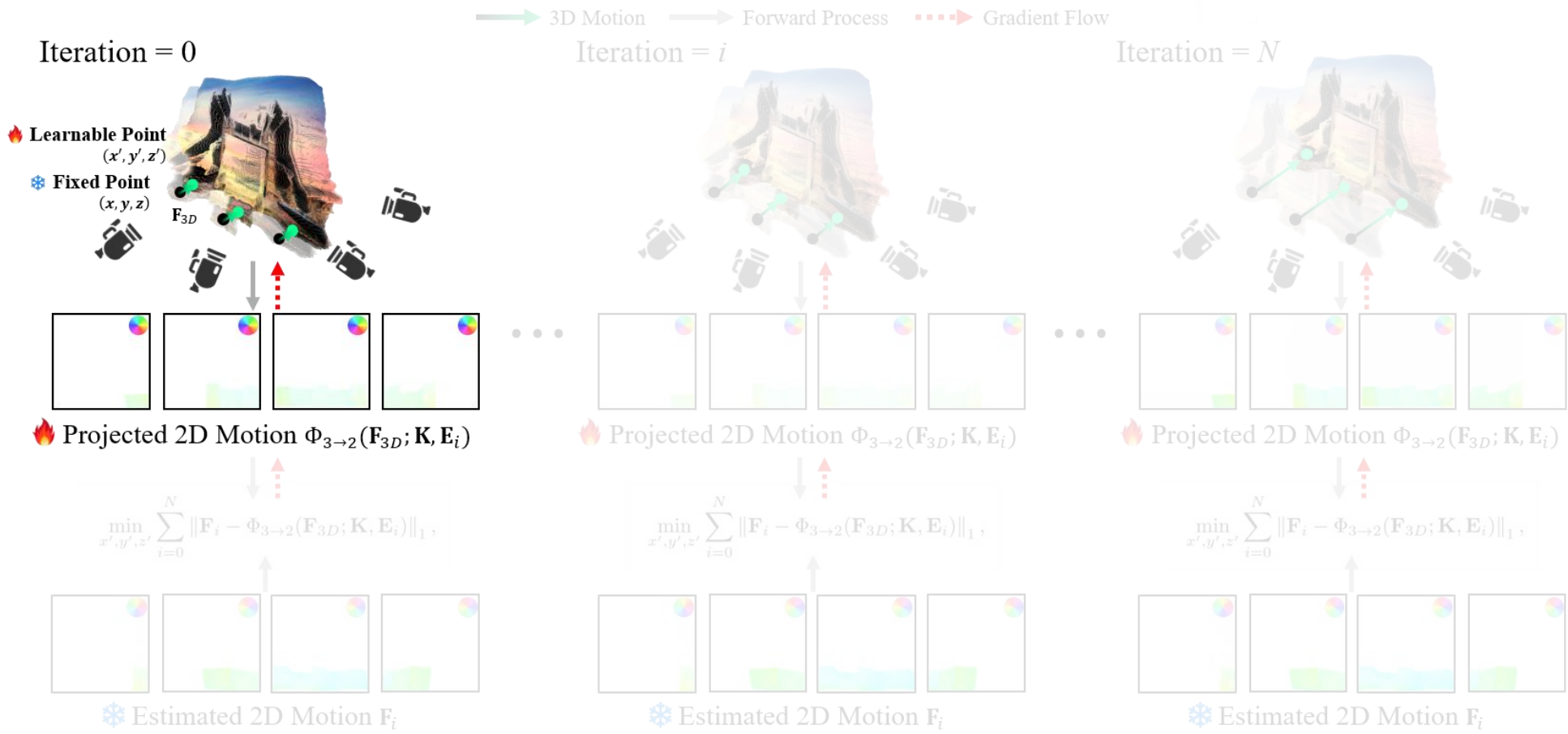
Our Method

3D Motion Optimization Module (3D-MOM)



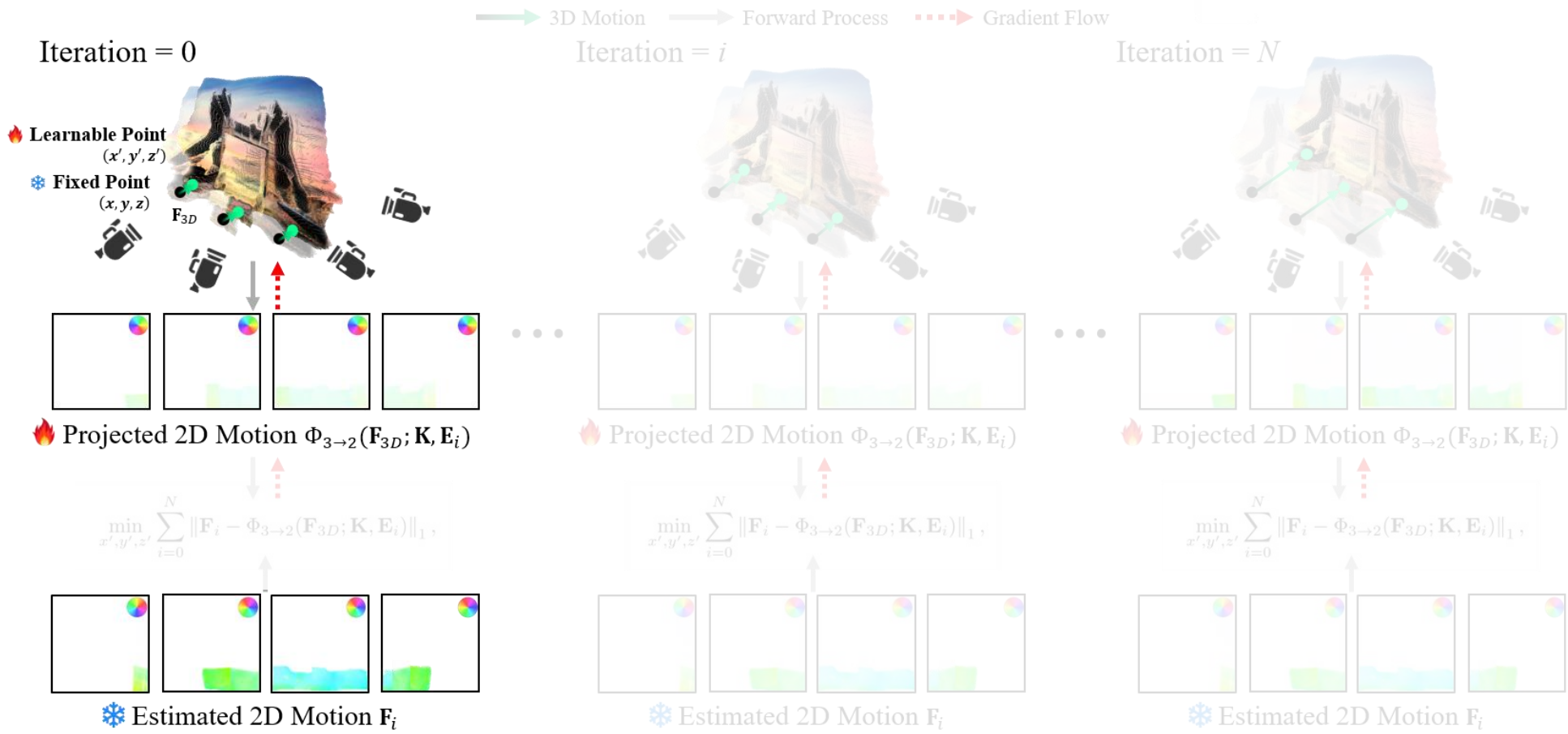
Our Method

3D Motion Optimization Module (3D-MOM)



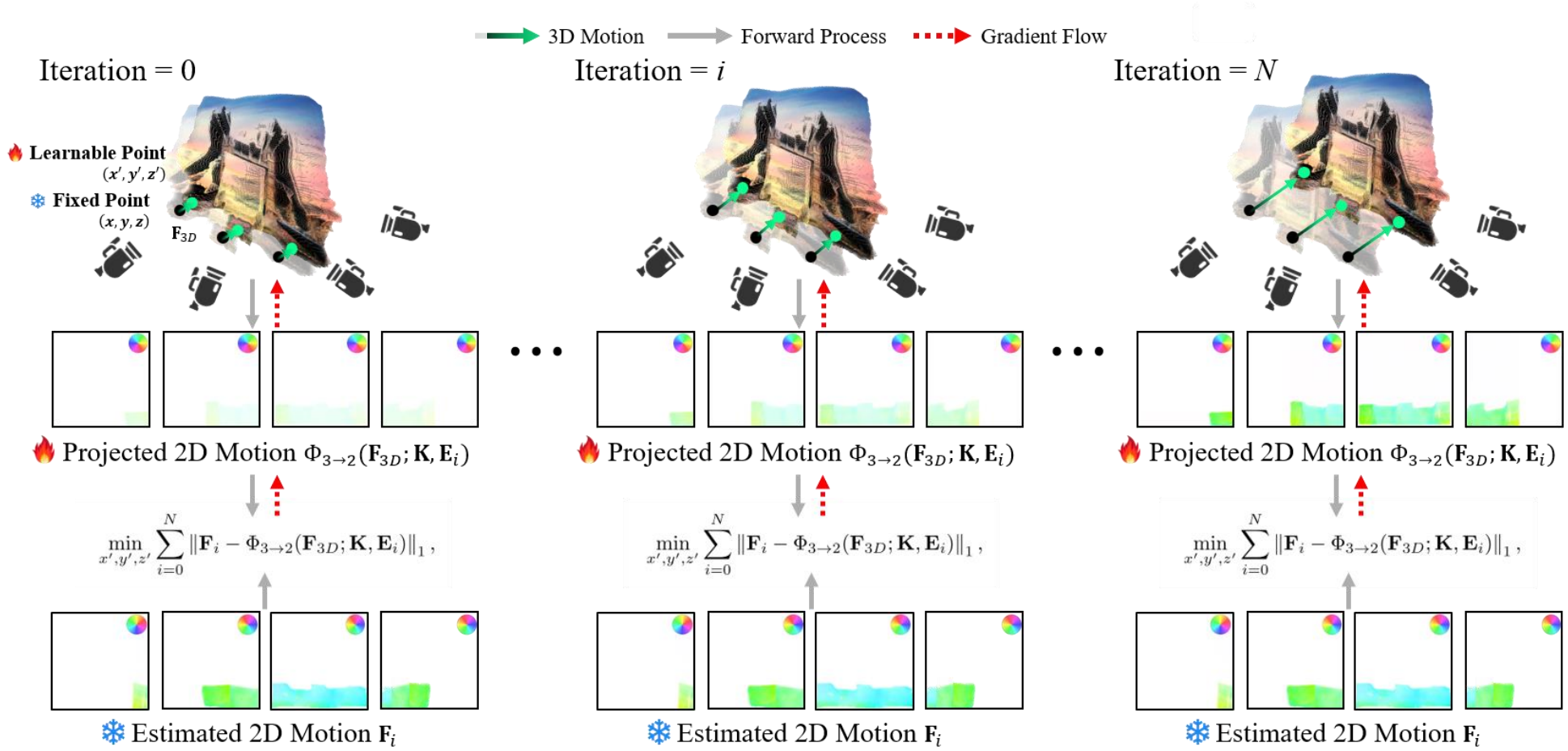
Our Method

3D Motion Optimization Module (3D-MOM)

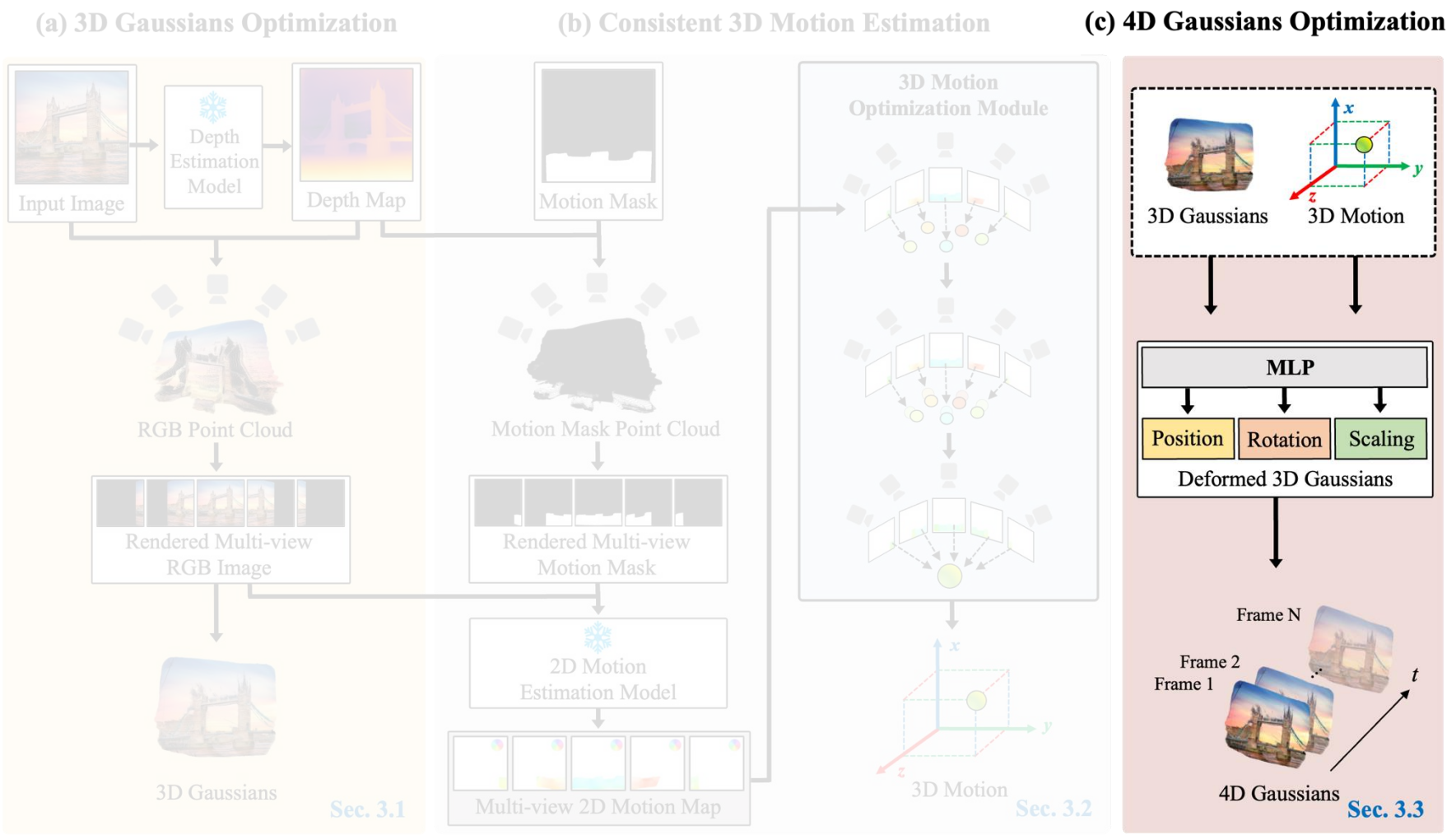


Our Method

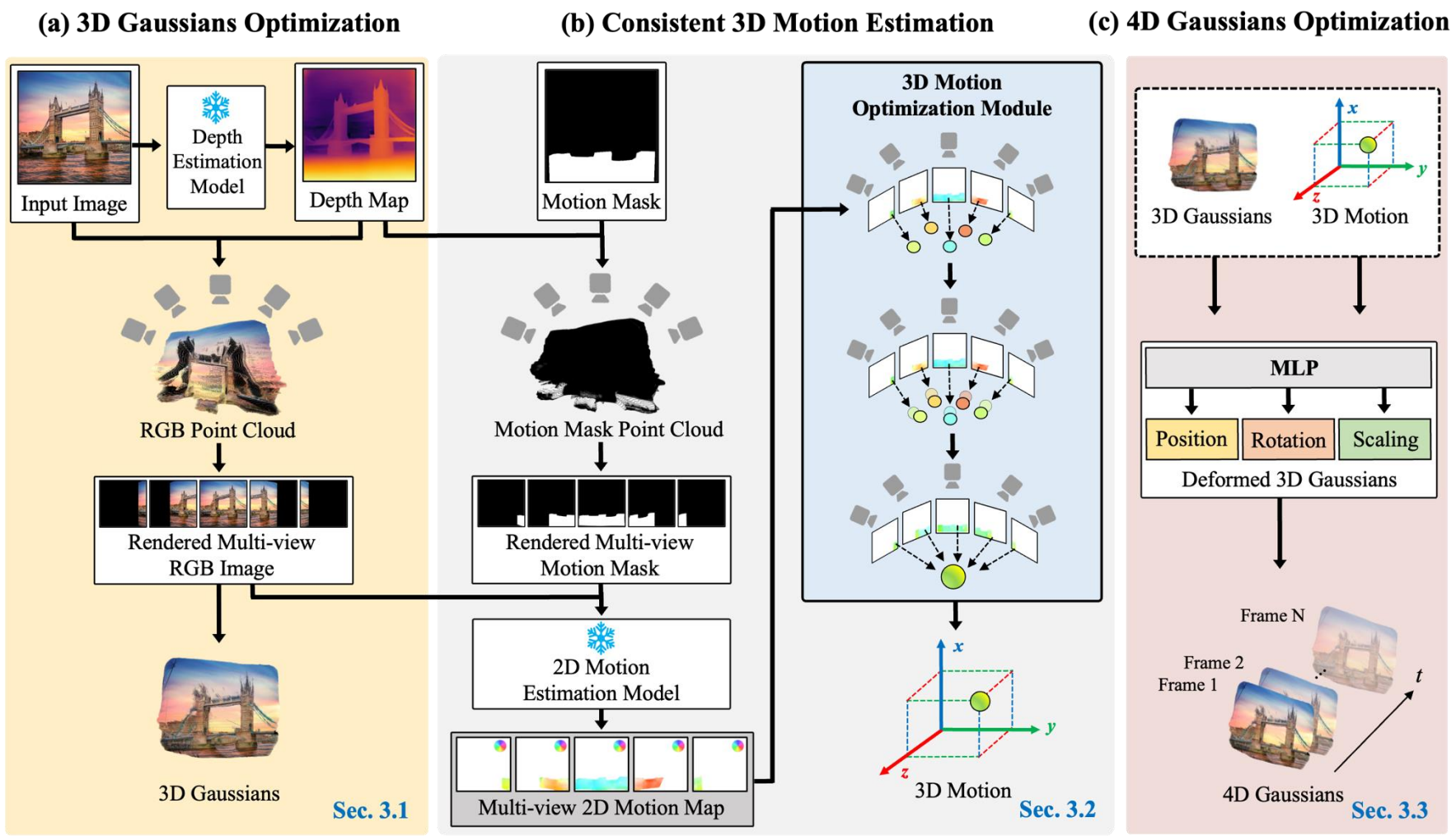
3D Motion Optimization Module (3D-MOM)



Our Method


(a) 3D Gaussians Optimization
(b) Consistent 3D Motion Estimation
(c) 4D Gaussians Optimization
Input Image
Depth Estimation Model
Depth Map
Motion Mask
3D Motion Optimization Module
RGB Point Cloud
Motion Mask Point Cloud
Rendered Multi-view RGB Image
Rendered Multi-view Motion Mask
2D Motion Estimation Model
3D Gaussians
Multi-view 2D Motion Map
3D Motion
Sec. 3.1
Sec. 3.2
3D Gaussians
3D Motion
MLP
Position
Rotation
Scaling
Deformed 3D Gaussians
Frame N
Frame 2
Frame 1
4D Gaussians
Sec. 3.3

Our Method


(a) 3D Gaussians Optimization
(b) Consistent 3D Motion Estimation
(c) 4D Gaussians Optimization
Input Image
Depth Estimation Model
Depth Map
RGB Point Cloud
Rendered Multi-view RGB Image
3D Gaussians
Sec. 3.1
Motion Mask
Motion Mask Point Cloud
Rendered Multi-view Motion Mask
2D Motion Estimation Model
Multi-view 2D Motion Map
3D Motion Optimization Module
3D Motion
Sec. 3.2
3D Gaussians
3D Motion
MLP
Position
Rotation
Scaling
Deformed 3D Gaussians
Frame N
Frame 2
Frame 1
4D Gaussians
Sec. 3.3

Experimental Results

1) Results of Holynski Dataset

Input Image

DynamiCrafter [8]

Motion-I2V [9]

Make-It-4D [2]

3D Cinemagraphy [1]

Ours

[8] DynamiCrafter: Animating Open-domain Images with Video Diffusion Priors *ECCV 2024, Oral*

[9] Motion-I2V: Consistent and Controllable Image-to-Video Generation with Explicit Motion Modeling *SIGGRAPH 2024*

Experimental Results

1) Results of “In-the-Wild” Dataset

Input Image

Make-It-4D [2]

3D Cinemagraphy [1]

Ours

Quantitative Results

Method	Metrics				User study (%)			
	PSNR ↑	SSIM ↑	LPIPS ↓	PIQE ↓	Immersion	Realism	Stuctural Consistency	Quality
DynamiCrafter (Xing et al., 2025)	14.98	0.81	0.23	24.58	-	-	-	-
Motion-I2V (Shi et al., 2024)	14.38	0.80	0.31	8.4	-	-	-	-
3D-Cinemagraphy (Li et al., 2023)	17.30	0.83	0.17	8.93	31.87	31.87	28.75	30.31
Make-It-4D (Shen et al., 2023)	16.98	0.81	0.20	8.30	11.87	10.31	8.43	9.06
Ours	**20.57**	**0.90**	**0.14**	**7.80**	**56.25**	**57.81**	**62.81**	**60.25**

Application: 4D Scene Generation

3D Scene Generation

ViewCrafter [10]

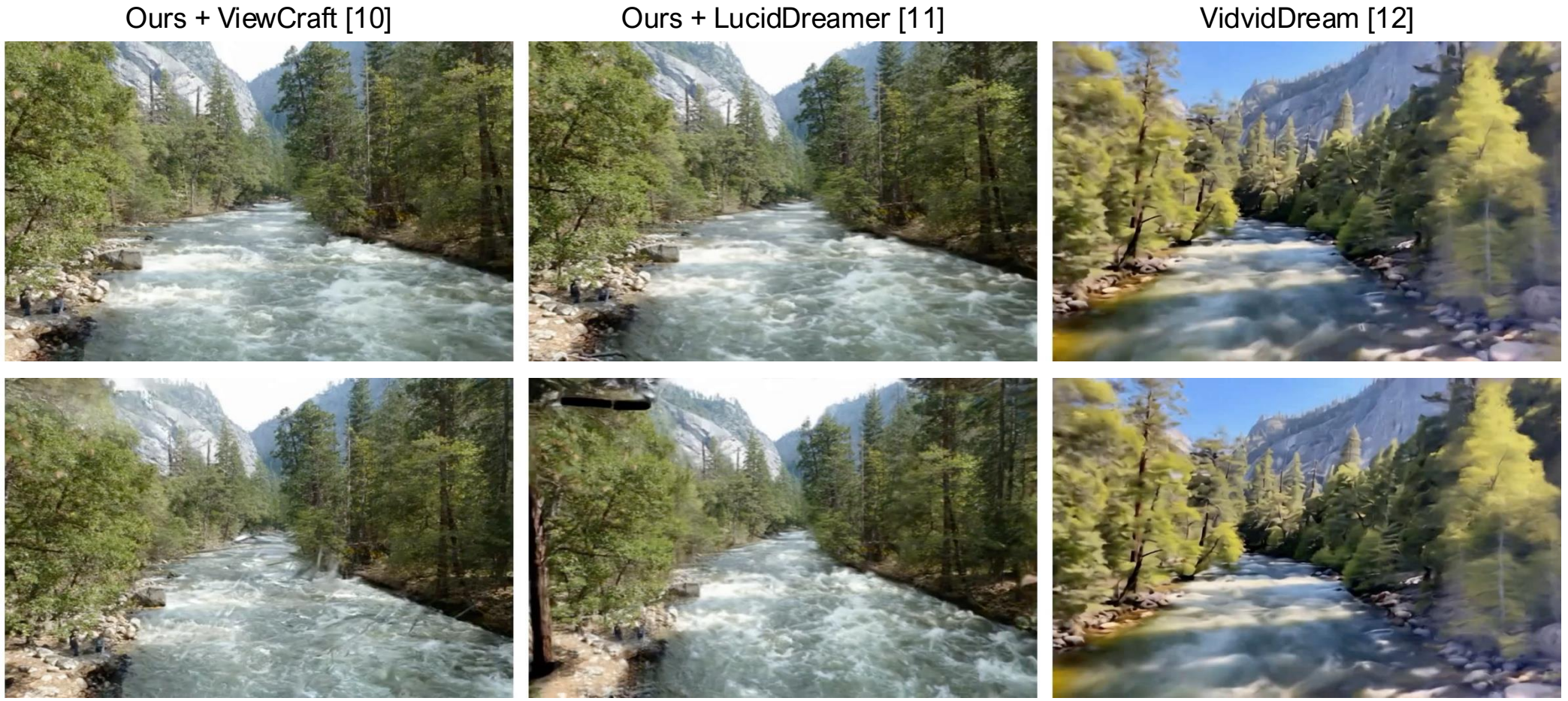
LucidDreamer [11]

[10] ViewCrafter: Taming Video Diffusion Models for High-fidelity Novel View Synthesis *arXiv 2024*

[11] LucidDreamer: Domain-free Generation of 3D Gaussian Splatting Scenes *arXiv 2023*

Application: 4D Scene Generation

1) Comparative Result with VividDream



Application: 4D Scene Generation

2) 3D Scene Generation + Dynamic Scene Video

Ours	Ours + LucidDreamer [11]
	
	

Thank you

We strongly encourage readers to view the additional results and ablations on the project page at