中国科学技术大学
University of Science and Technology of China

NEURAL INFORMATION PROCESSING SYSTEMS

MotionGS: Exploring Explicit Motion Guidance for Deformable 3D Gaussian Splatting

Ruijie Zhu*, Yanzhe Liang*, Hanzhi Chang, Jiacheng Deng, Jiahao Lu,
Wenfei Yang, Tianzhu Zhang†, Yongdong Zhang

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Problem Statement

Input: Multi-view images captured in a **Dynamic** scene (usually by **a moving camera**) and their poses

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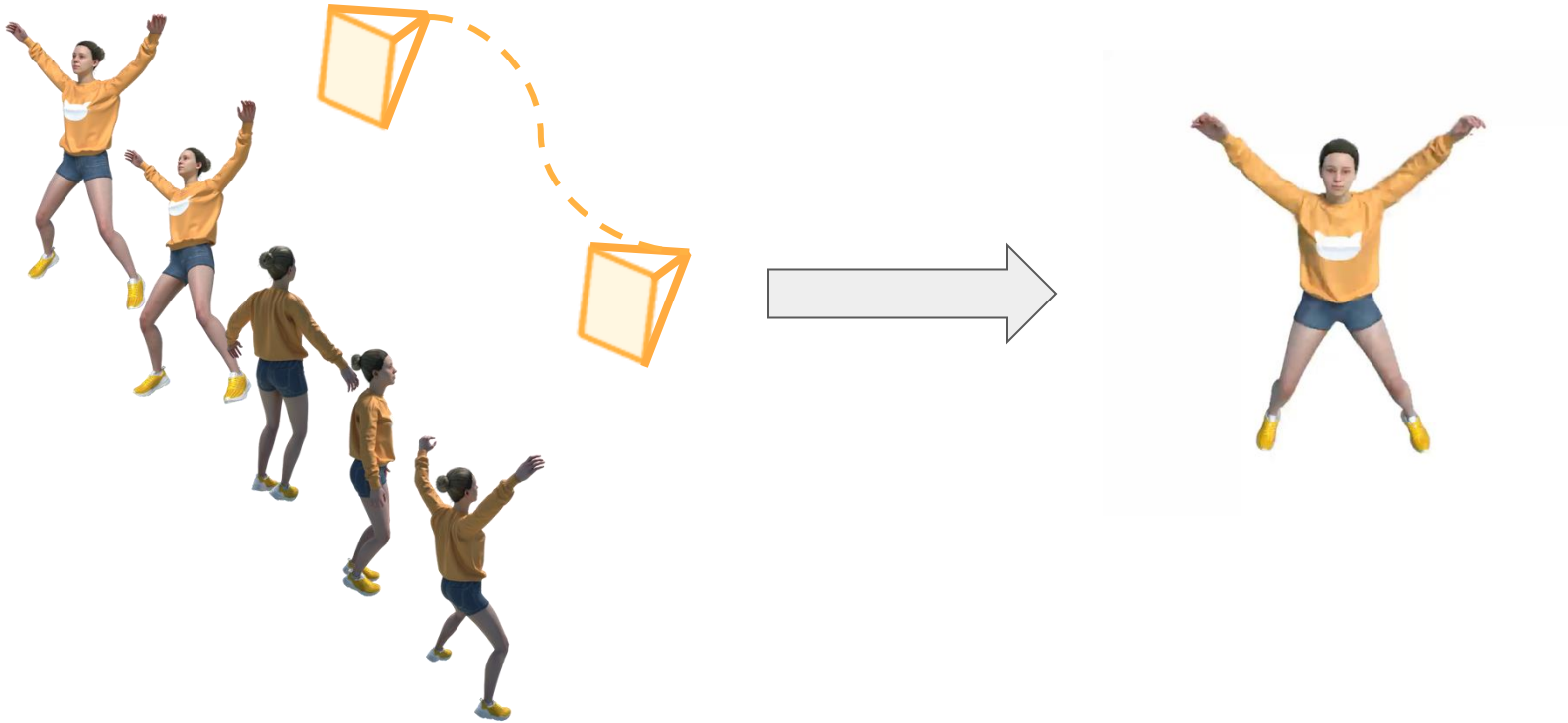
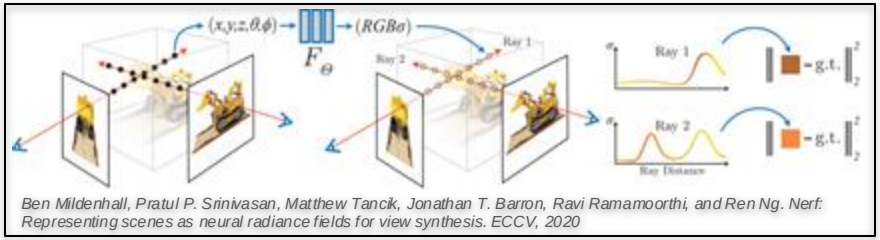
Input: Multi-view images captured in a **Dynamic** scene (usually by **a moving camera**) and their poses

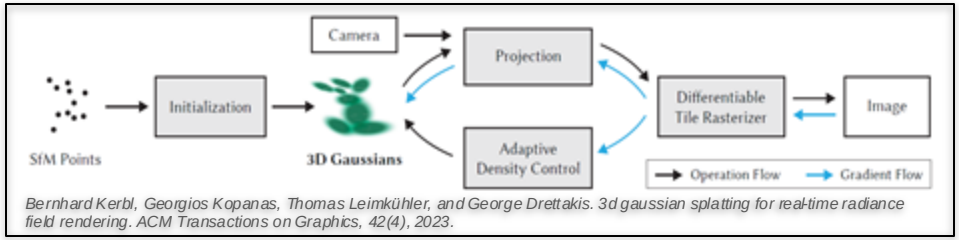
Output: A reconstructed 3D model with **realistic appearance** and **natural motion**, continuously capturing dynamic changes over time.



Related Work



Ben Mildenhall, Pratul P. Srinivasan, Matthew Tancik, Jonathan T. Barron, Ravi Ramamoorthi, and Ren Ng. Nerf: Representing scenes as neural radiance fields for view synthesis. ECCV, 2020



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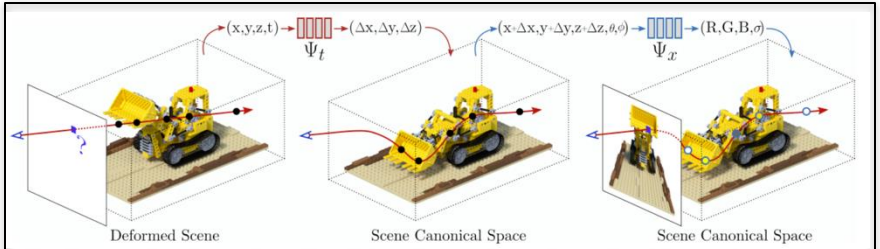

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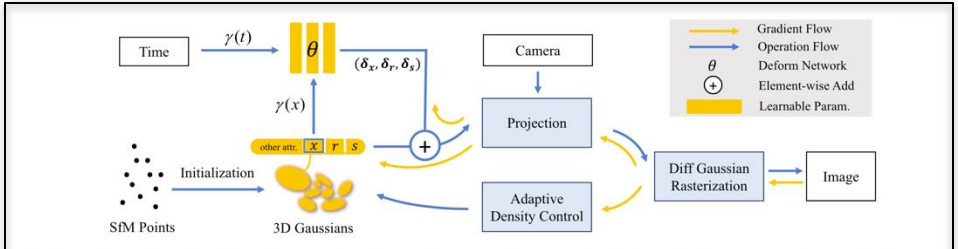

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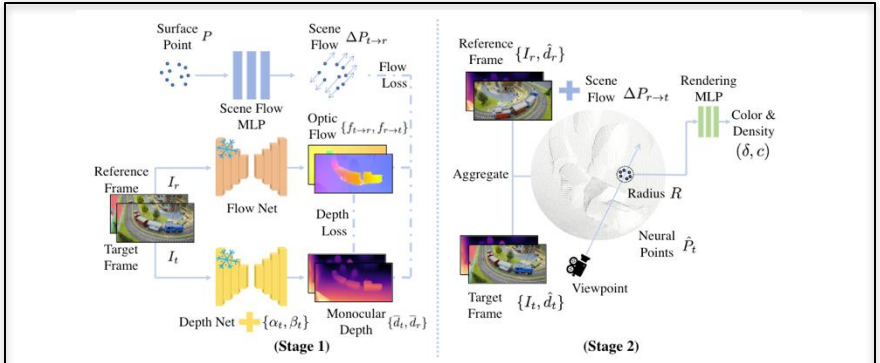
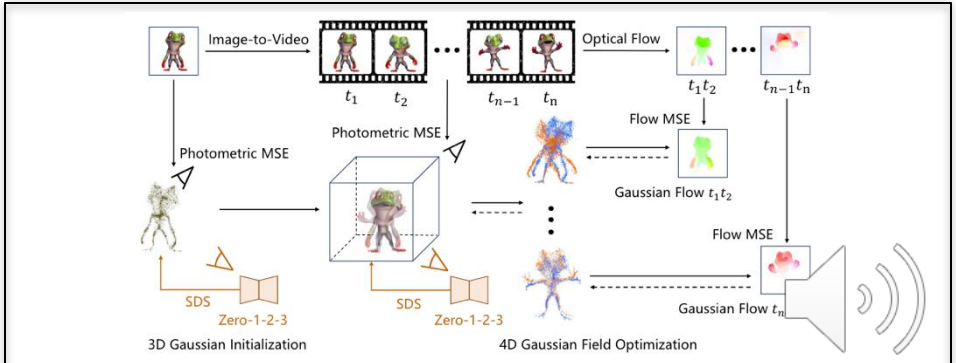


Kaichen Zhou, Jia-Xing Zhong, Sangyun Shin, Kai Lu, Yiyuan Yang, Andrew Markham, and Niki Trigoni. Dynpoint: Dynamic neural point for view synthesis. Advances in Neural Information Processing Systems, 36, 2023.

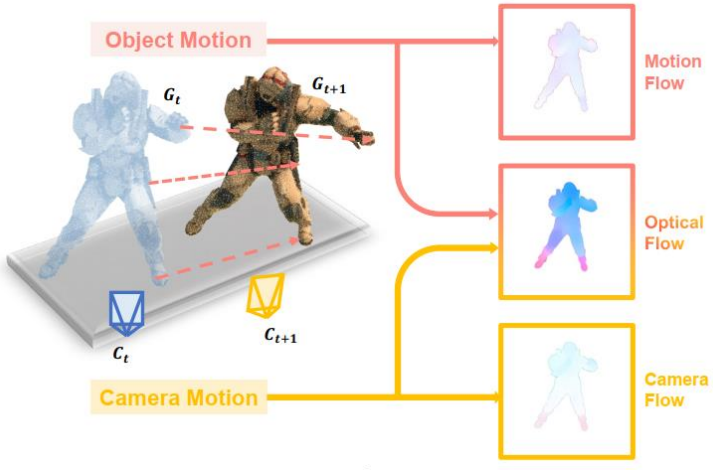


Quankai Gao, Qiangeng Xu, Zhe Cao, Ben Mildenhall, Wenchao Ma, Le Chen, Danhang Tang, and Ulrich Neumann. Gaussianflow: Splatting gaussian dynamics for 4d content creation. arXiv preprint arXiv:2403.12365, 2024.

Our Motivation

1. Most existing dynamic 3DGS methods simply use deformation fields to model Gaussian motion, which lacks explicit motion constraints.

2. Compared with using optical flow to supervise Gaussian deformation, we decouple motion flow from optical flow to directly provide explicit motion priors, thus making motion constraints more effective.



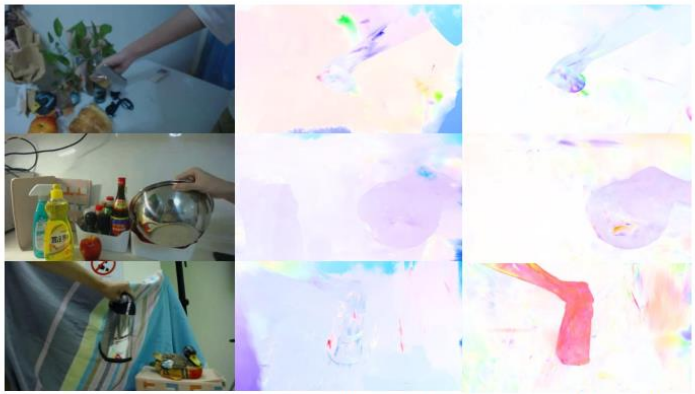
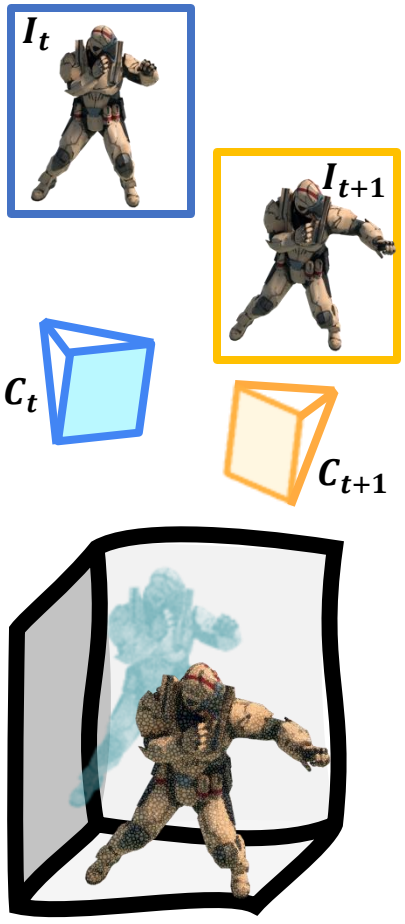
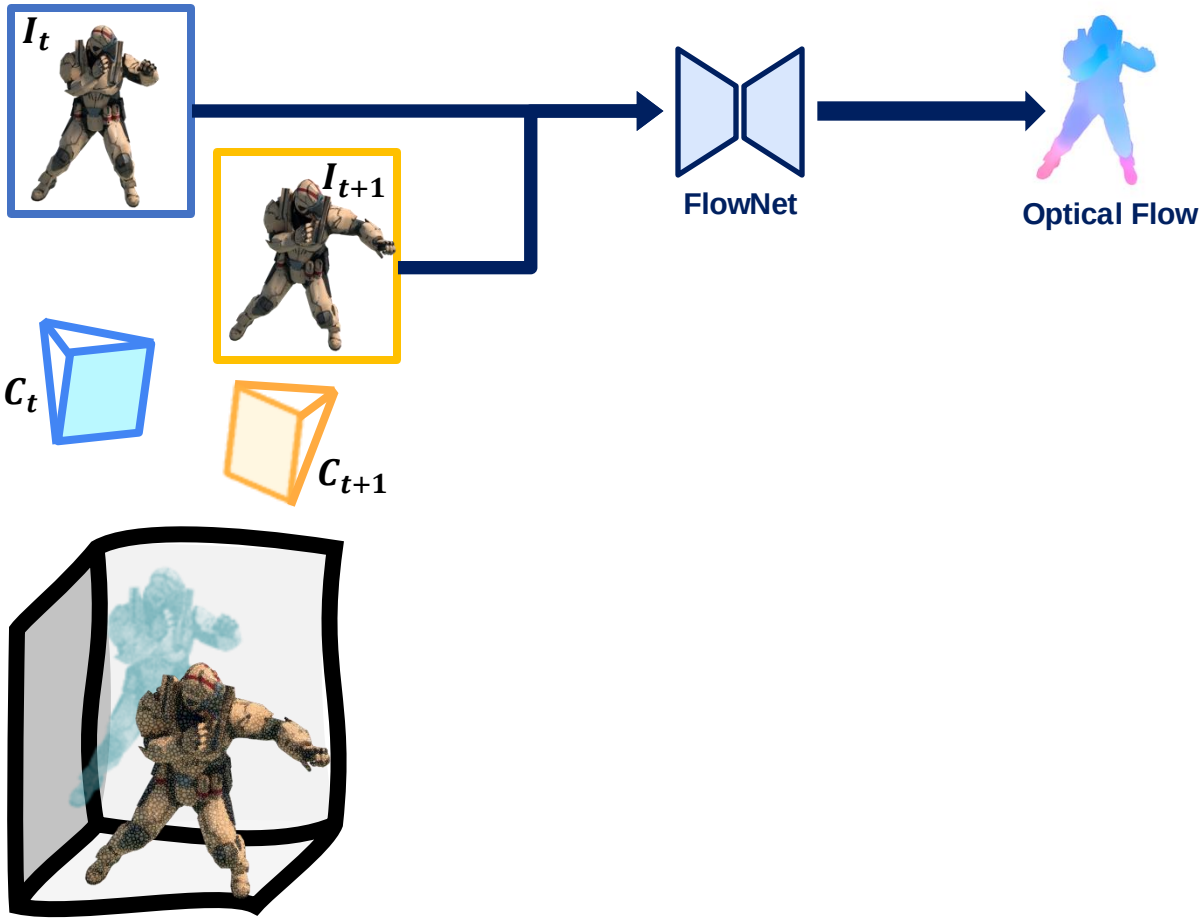


Image input | Gaussian flow under **optical flow** supervision | Gaussian flow under **motion flow** supervision

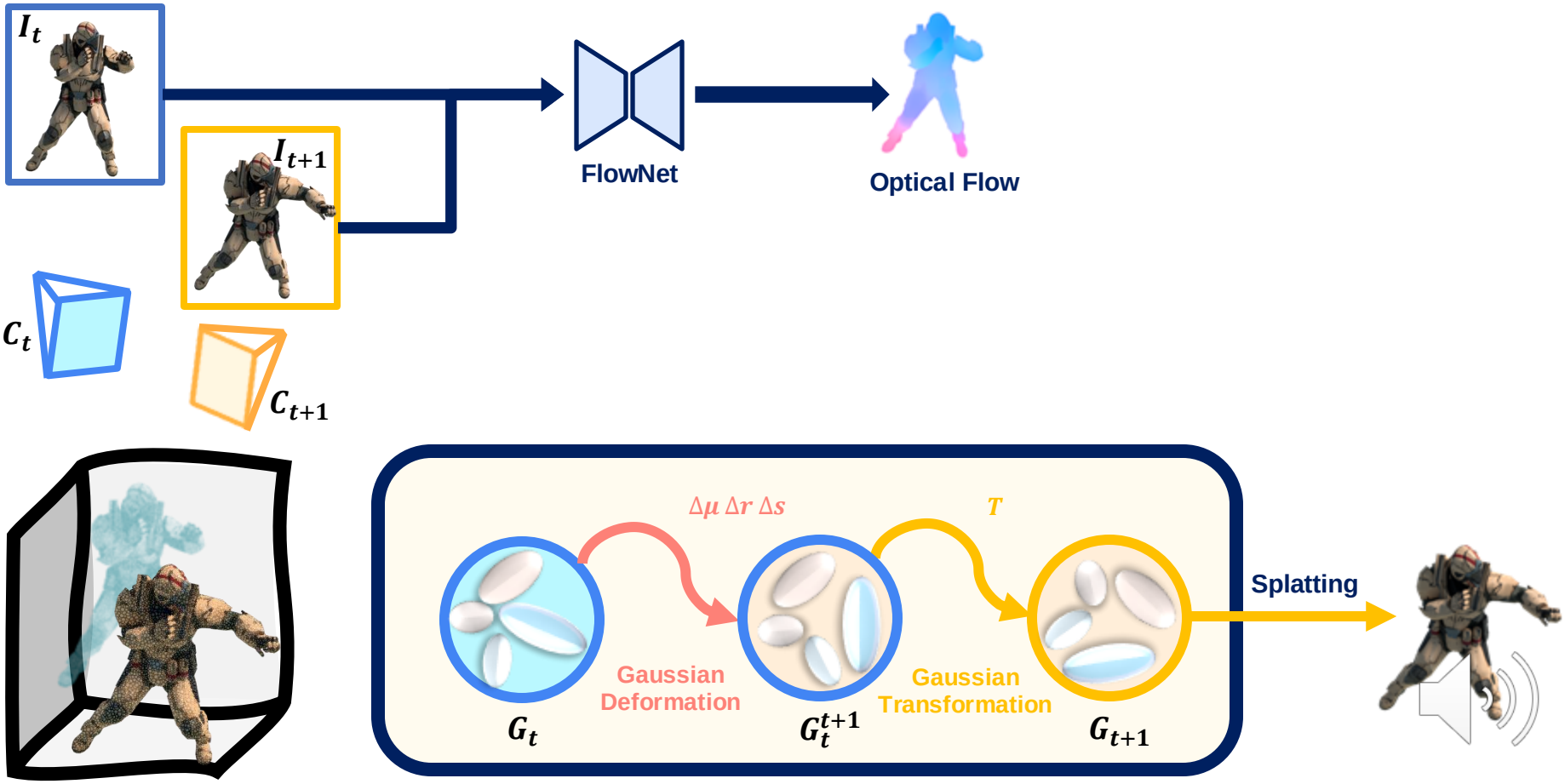
Framework



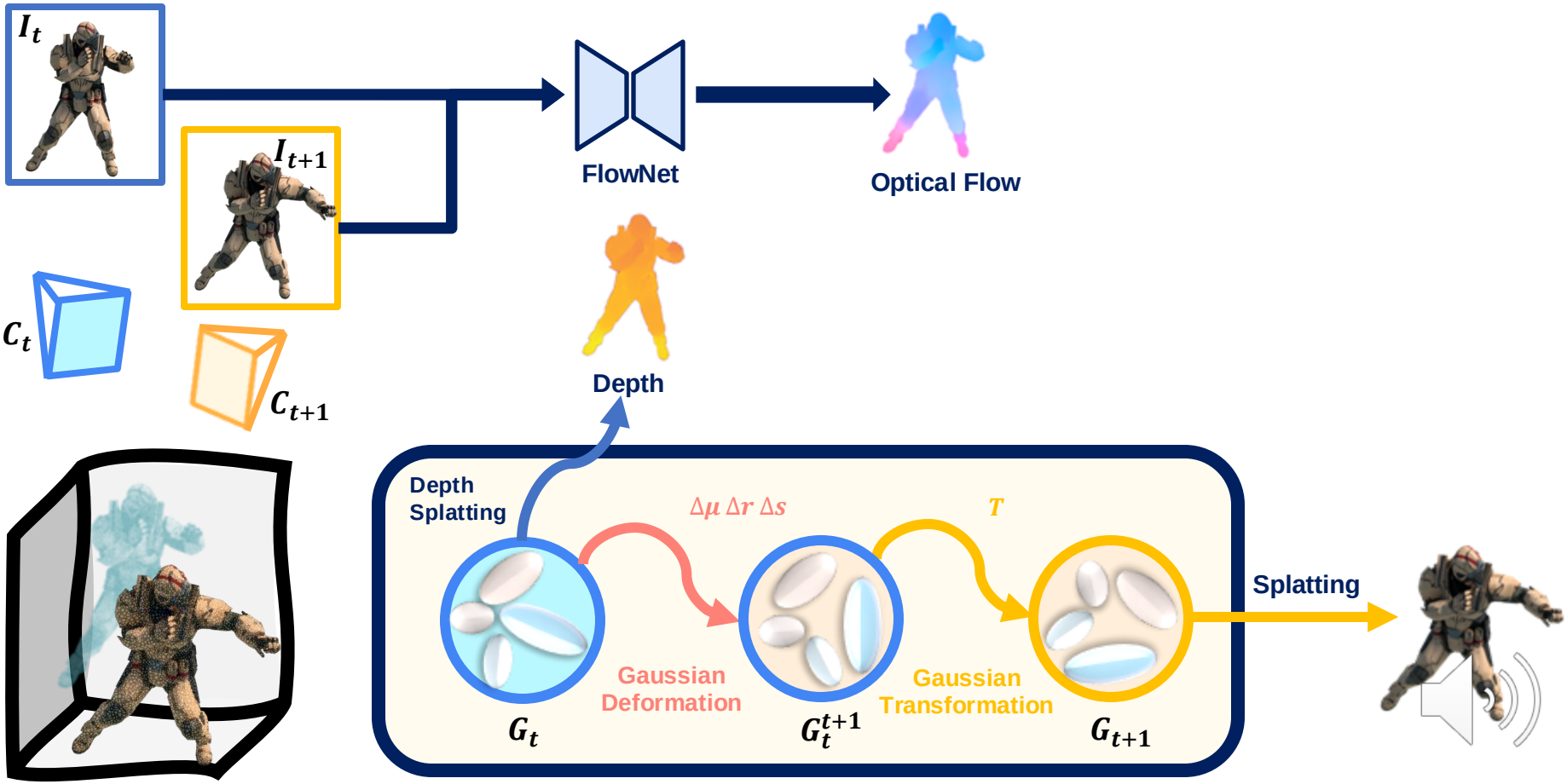
Framework



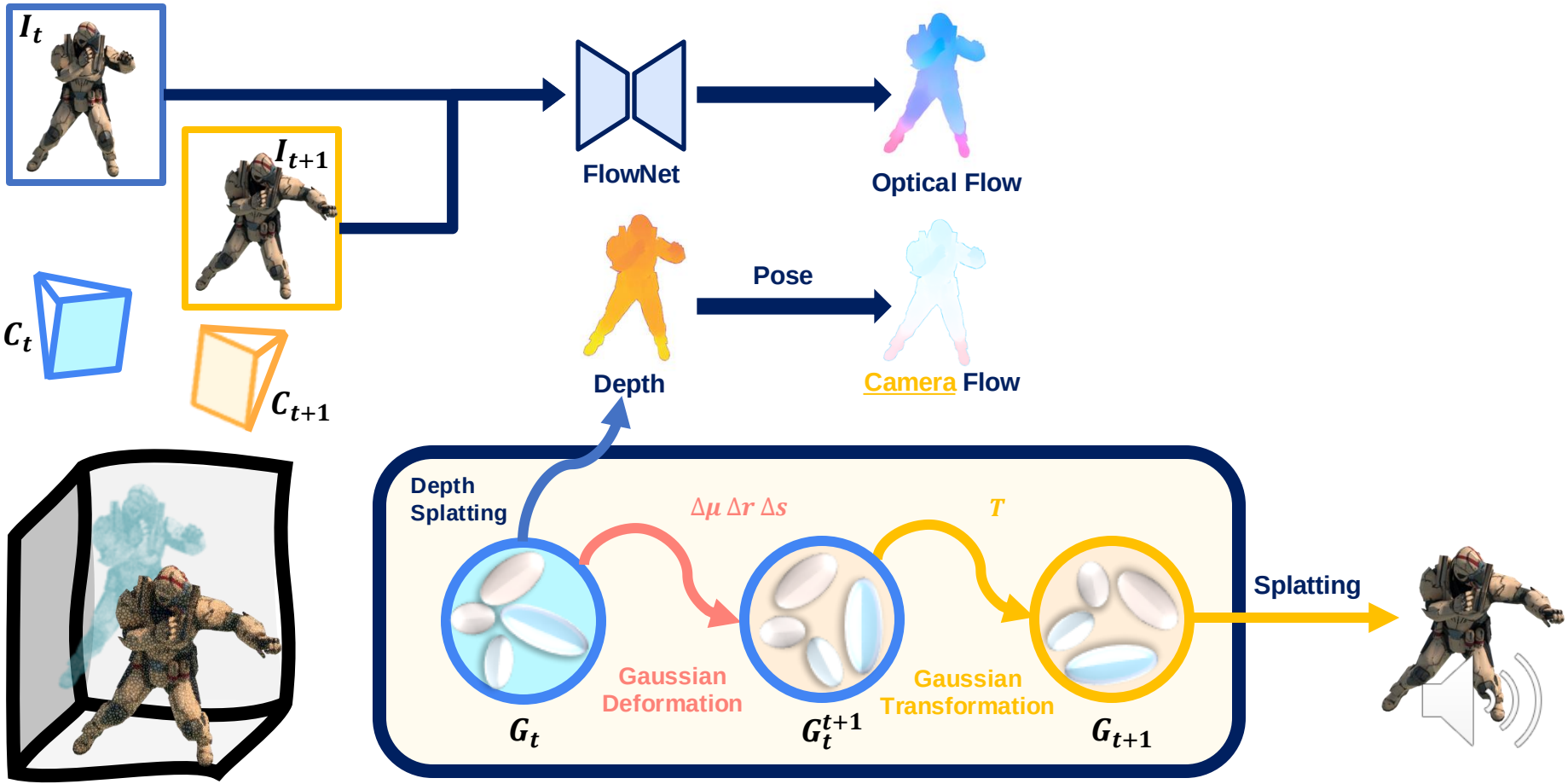
Framework


I_t
I_{t+1}
FlowNet
Optical Flow
C_t
C_{t+1}
$\Delta\mu\ \Delta r\ \Delta s$
T
Gaussian Deformation
Gaussian Transformation
G_t
G_t^{t+1}
G_{t+1}
Splatting

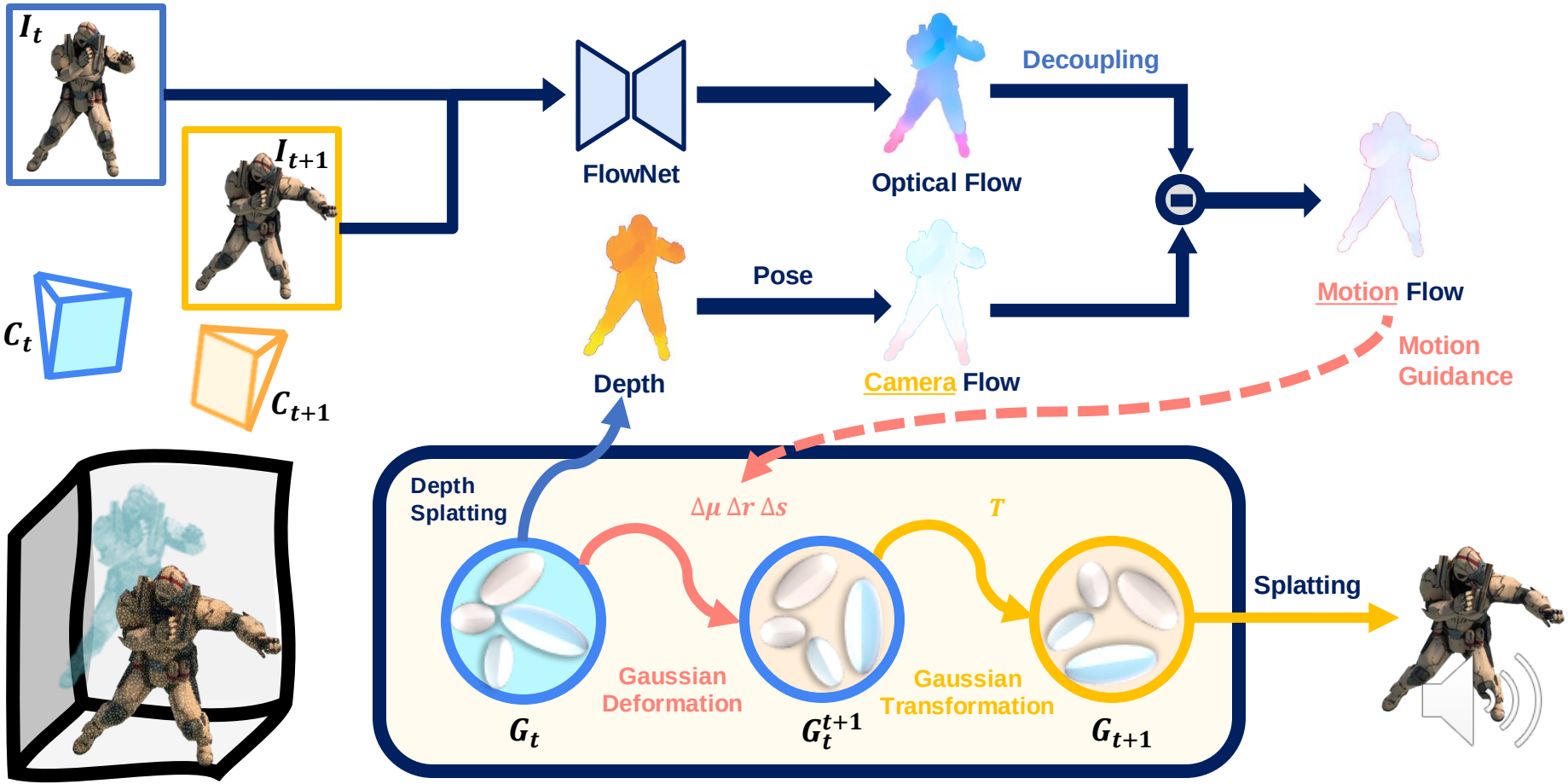
Framework


I_t
I_{t+1}
FlowNet
Optical Flow
C_t
C_{t+1}
Depth
Depth Splatting
$\Delta\mu\ \Delta r\ \Delta s$
T
Gaussian Deformation
Gaussian Transformation
G_t
G_t^{t+1}
G_{t+1}
Splatting

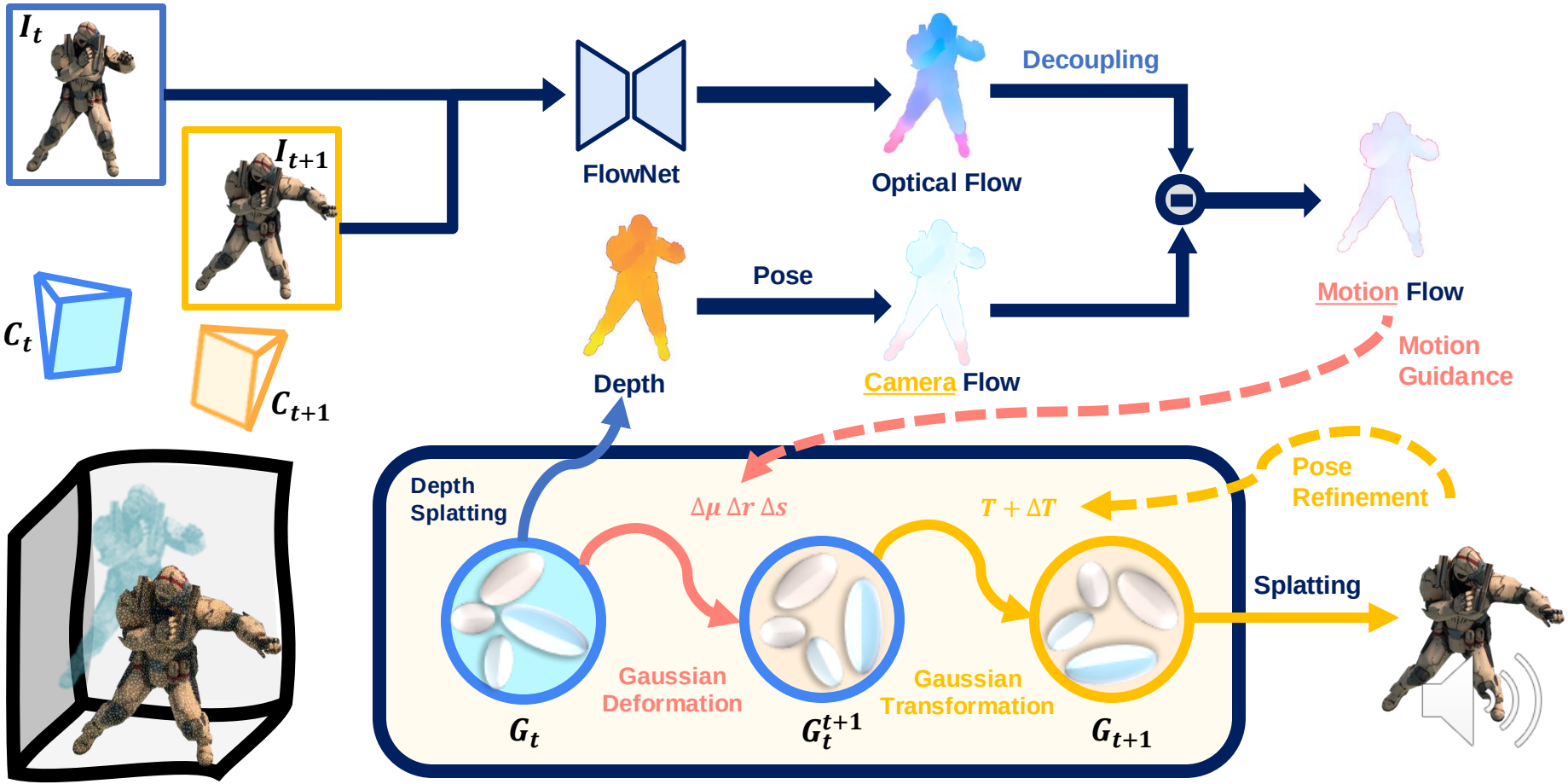
Framework


I_t
I_{t+1}
C_t
C_{t+1}
FlowNet
Optical Flow
Depth
Pose
Camera Flow
Depth Splatting
$\Delta\mu\ \Delta r\ \Delta s$
T
Gaussian Deformation
Gaussian Transformation
G_t
G_t^{t+1}
G_{t+1}
Splatting

Framework

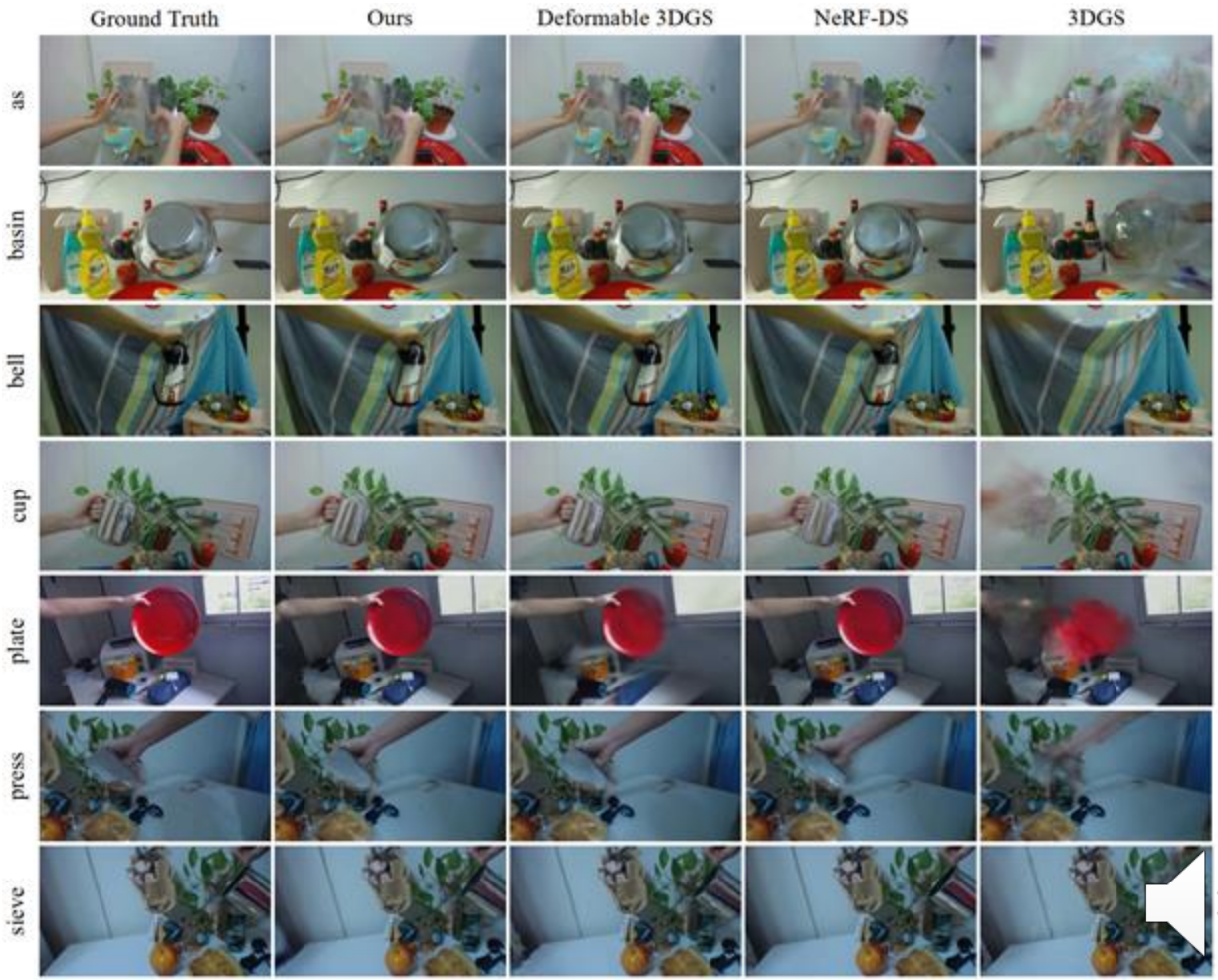

I_t
I_{t+1}
C_t
C_{t+1}
FlowNet
Optical Flow
Decoupling
Depth
Pose
Camera Flow
Motion Flow
Motion Guidance
Depth Splatting
$\Delta\mu\ \Delta r\ \Delta s$
T
Gaussian Deformation
Gaussian Transformation
G_t
G_t^{t+1}
G_{t+1}
Splatting

Framework


I_t
I_{t+1}
C_t
C_{t+1}
FlowNet
Optical Flow
Decoupling
Depth
Pose
Camera Flow
Motion Flow
Motion Guidance
Depth Splatting
$\Delta\mu\ \Delta r\ \Delta s$
$T + \Delta T$
Pose Refinement
Gaussian Deformation
Gaussian Transformation
Splatting
G_t
G_t^{t+1}
G_{t+1}

Comparison

NeRF-DS dataset



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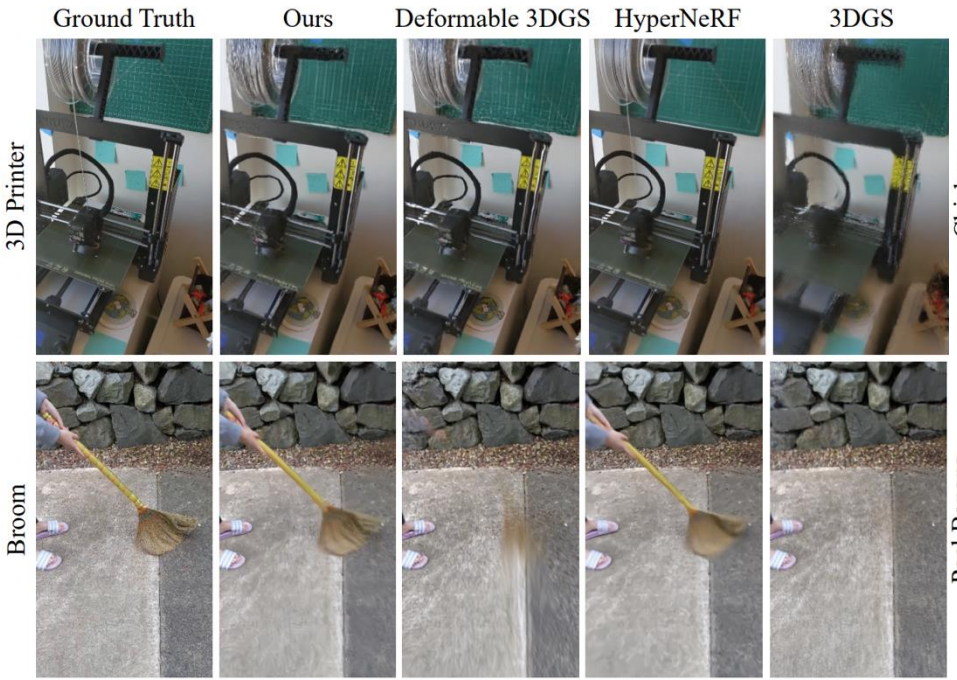
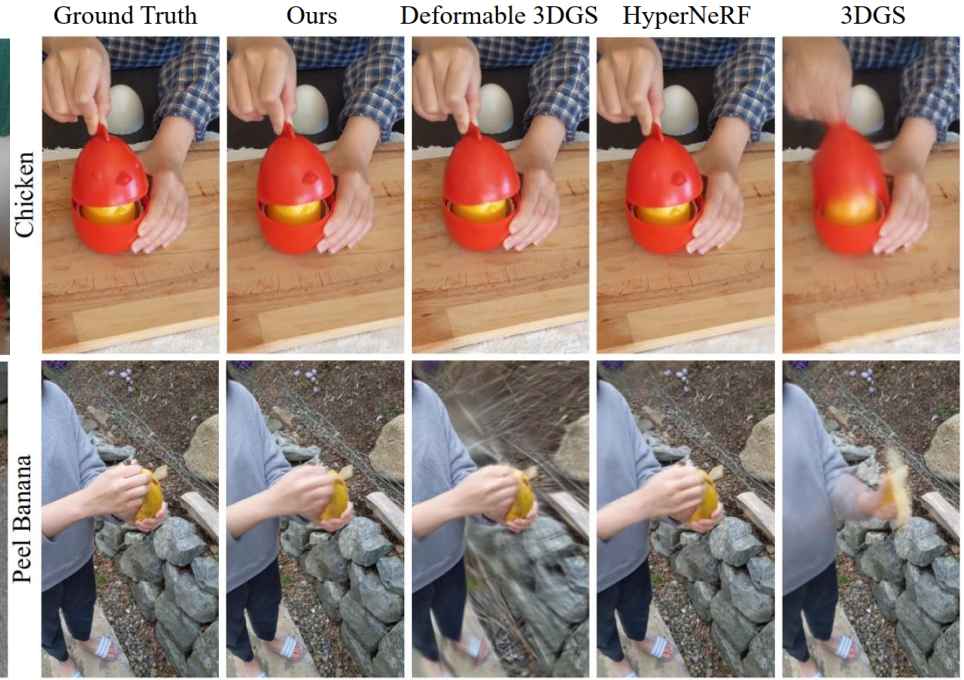
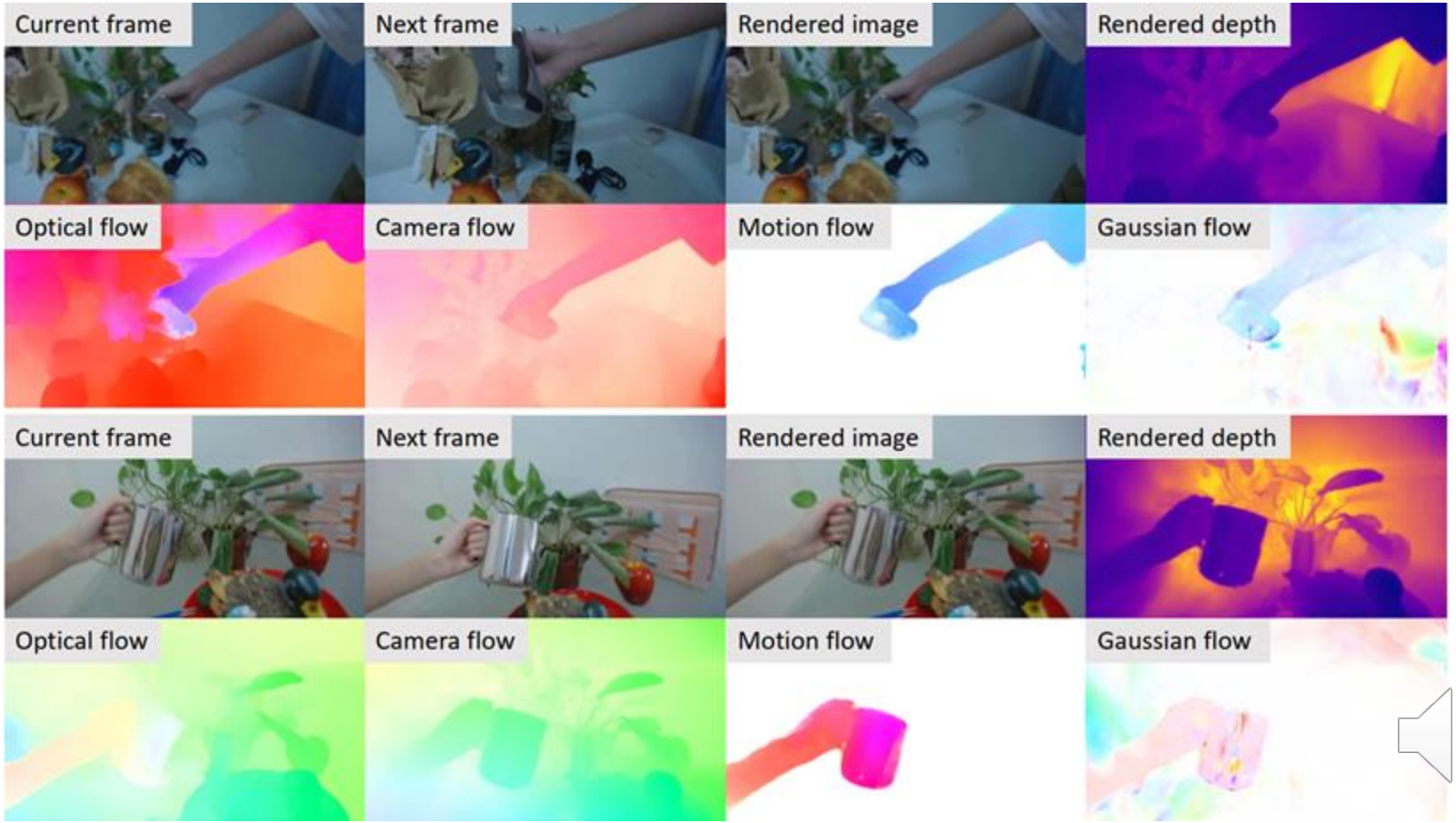




HyperNeRF dataset

Visualization



Visualization

Basin

As

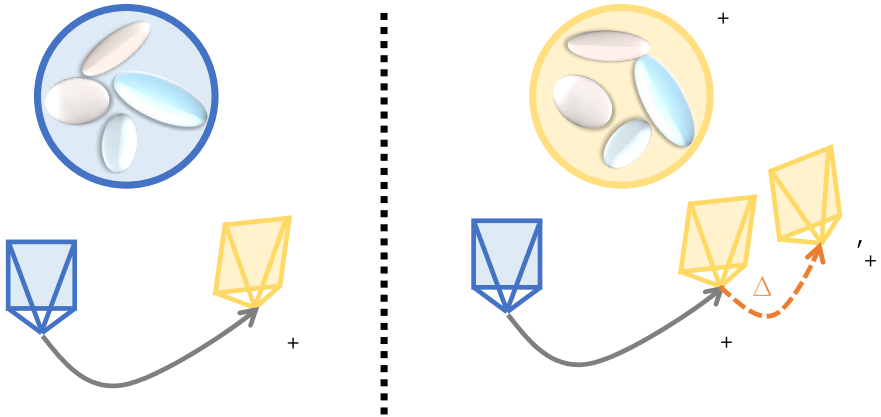
Cup

Sieve

Press

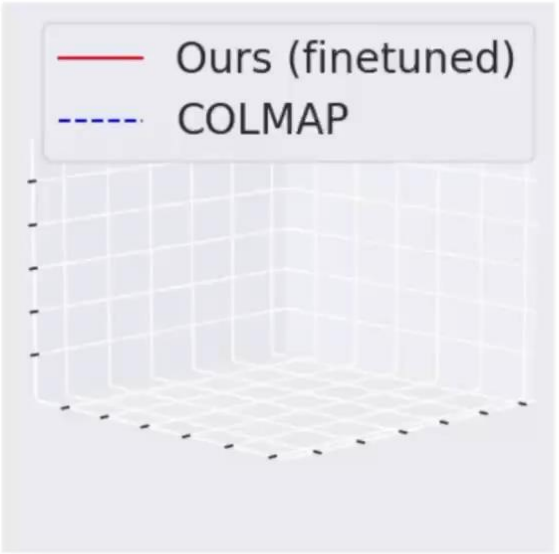
Bell

Visualization



Training Gaussians
(Camera Pose Fixed)

Finetuning Camera Pose
(Gaussians Fixed)



Thanks!

https://ruijiezhu94.github.io/MotionGS_page/