JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

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Temporal Interpolation Is All You Need for Dynamic Neural Radiance Field

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TUE-PM-008

Problem

Neural Radiance Field (NeRF) of Dynamic Scenes

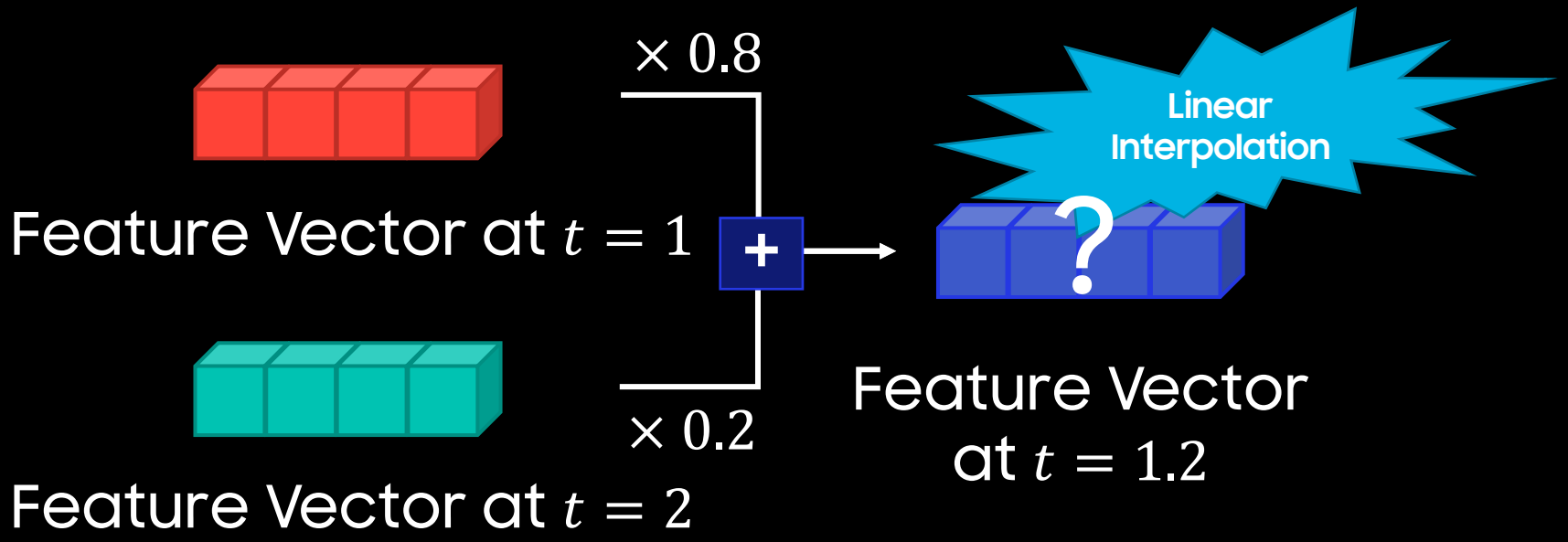
Input Sequence

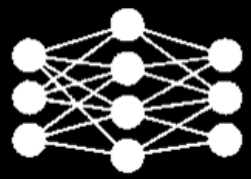
Dynamic NeRF

Space-Time View Synthesis

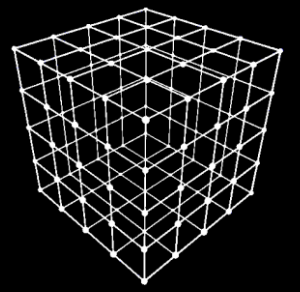
Key Idea

Temporal Interpolation





Neural Representation



Grid Representation

01 | Overview

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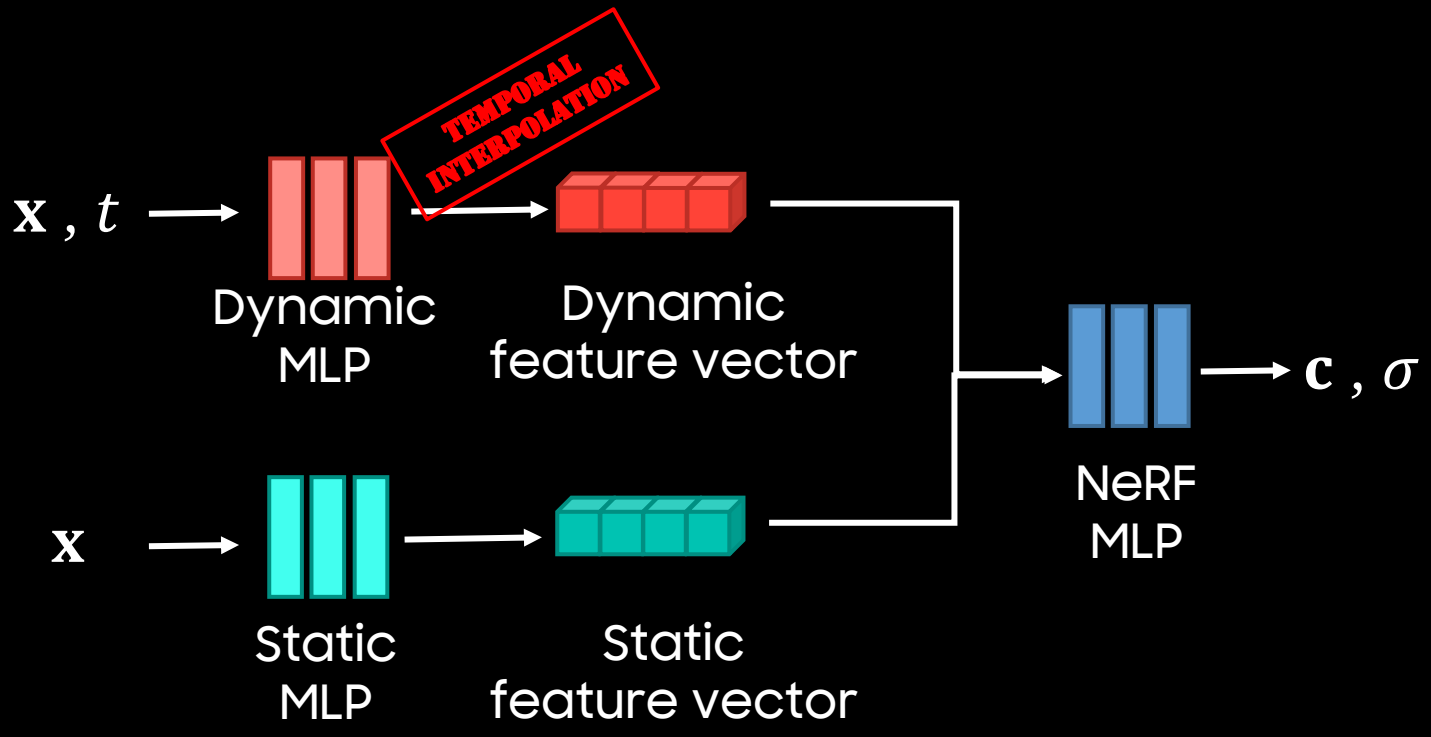
Neural Representation

Extract static and dynamic features via **neural nets**



High-quality dynamic NeRF

01 | Overview

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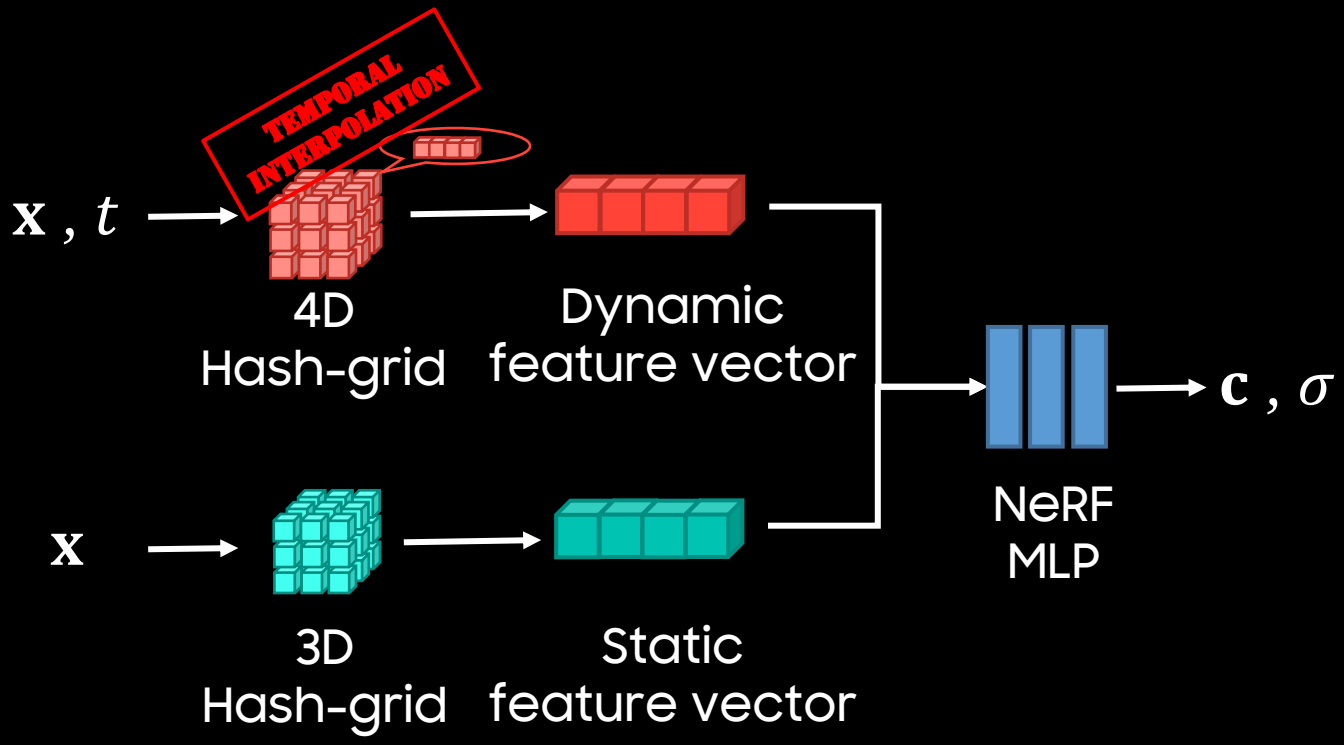
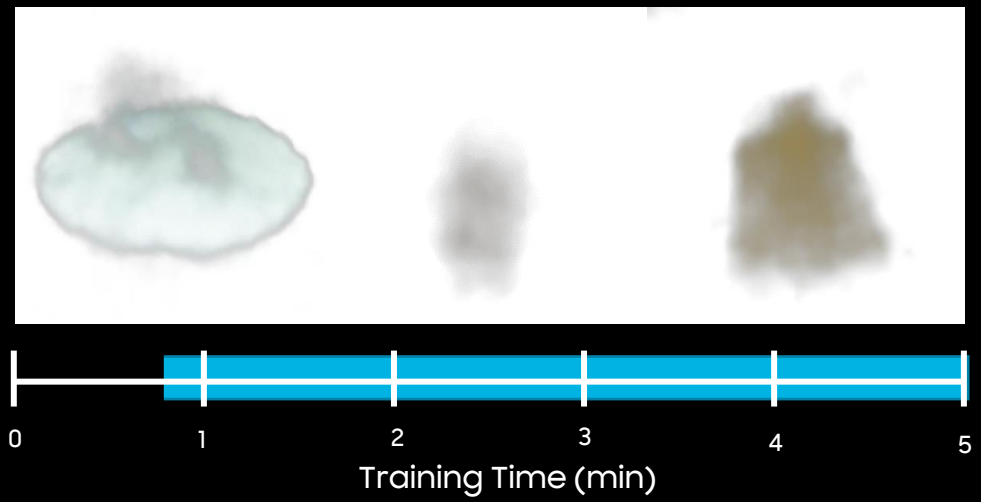
Grid Representation

Extract static and dynamic features via **hash grids** from InstantNGP





Fast-trained dynamic NeRF

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Project Page
https://sungheonpark.github.io/tempinterpnerf

Poster session (JUN 20)
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02 | Previous Works

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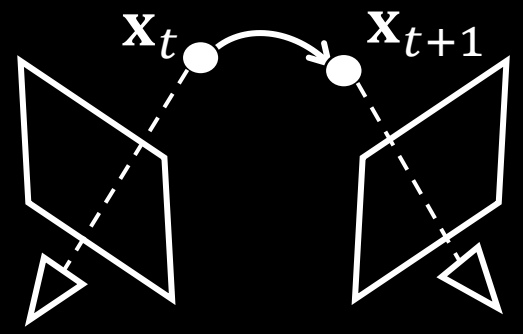
Dynamic NeRF

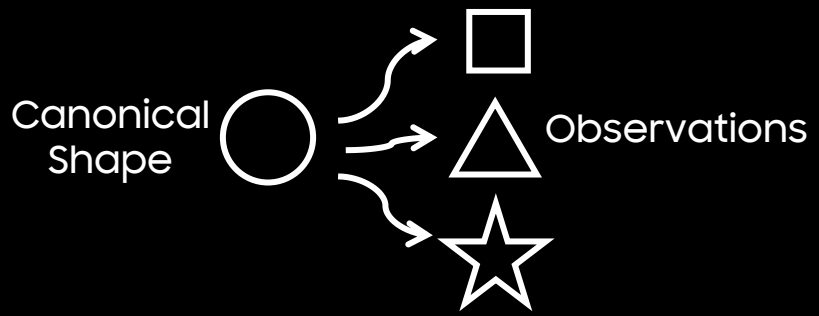
How to relate 3D points across frames?

3D Scene Flow



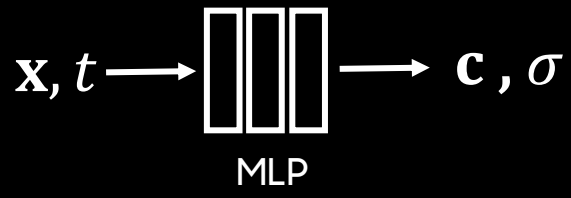
Neural Scene Flow Fields (CVPR 2021)

3D Warping



D-NeRF (CVPR 2021)
Nerfies (ICCV 2021)
HyperNeRF (SIGA 2021)
Non-rigid NeRF (ICCV 2021)

Direct Estimation



DyNeRF (CVPR 2022)

03 | Motivation

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Dynamic NeRF

Keep it SIMPLE!

No Scene Flow estimation module

No warping estimation module

Let the neural networks (or feature grids) learn meaningful representations

Temporal Interpolation + Smoothness Term

04 | Method

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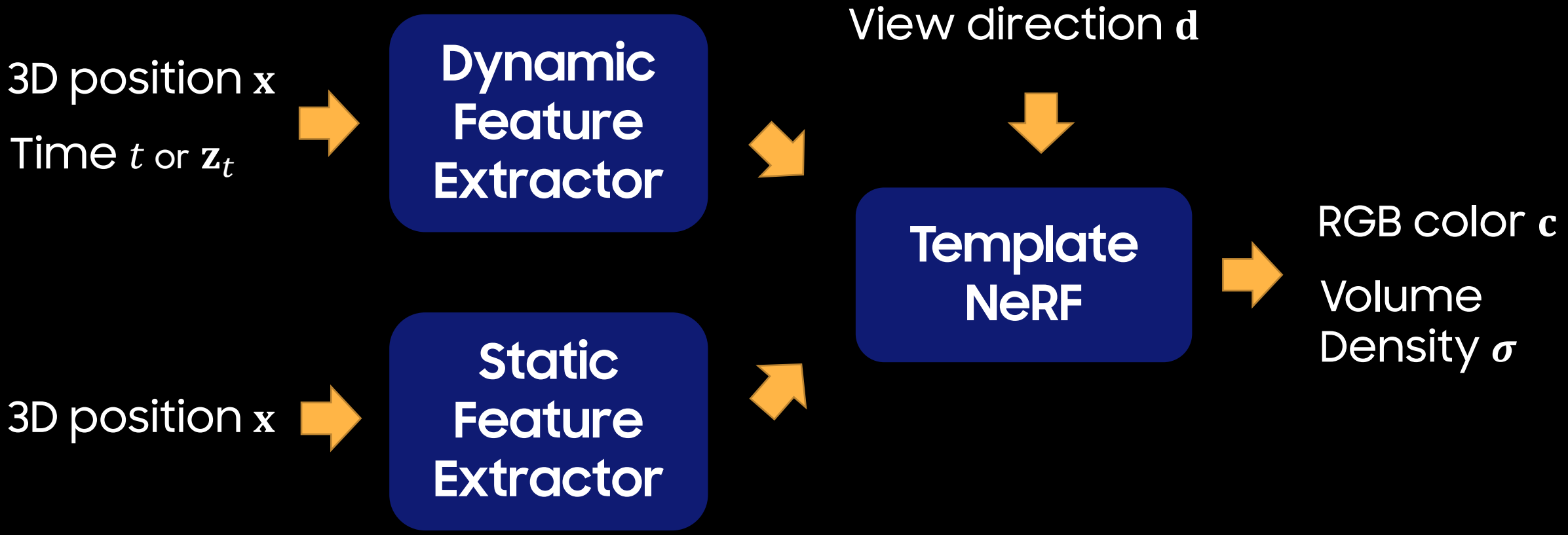

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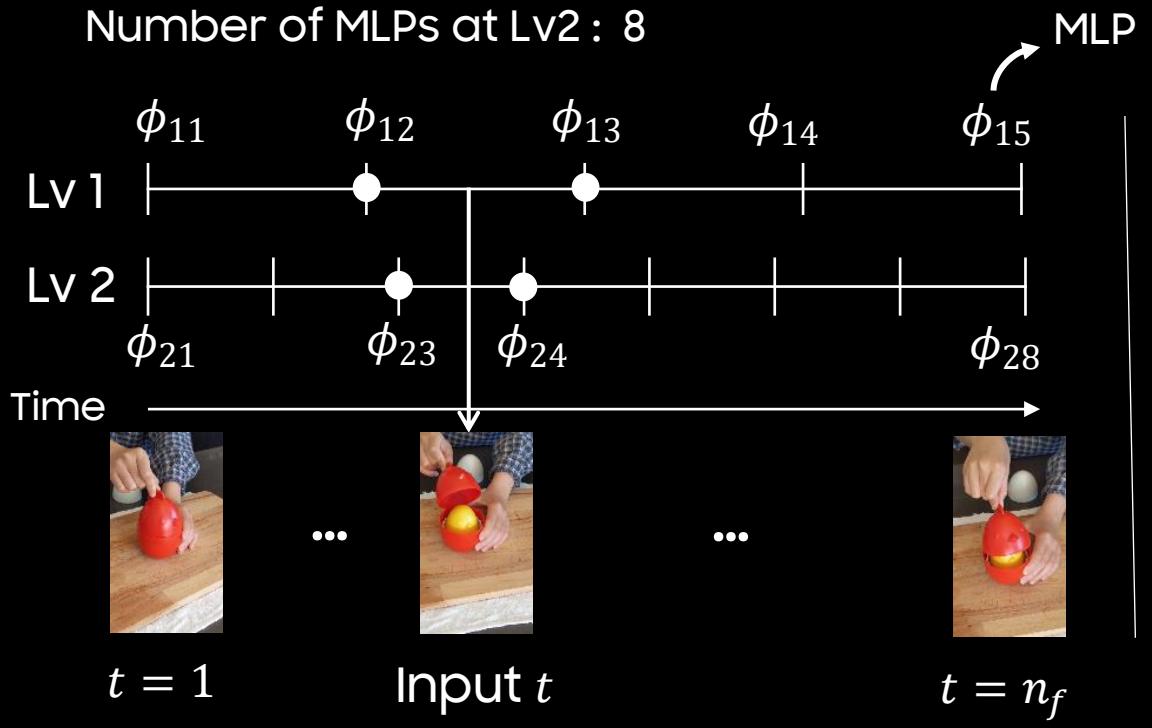
Neural representation

Extract static and dynamic features via **neural nets**

Structure of feature extractor

Levels : 2
Number of MLPs at Lv1 : 5
Number of MLPs at Lv2 : 8

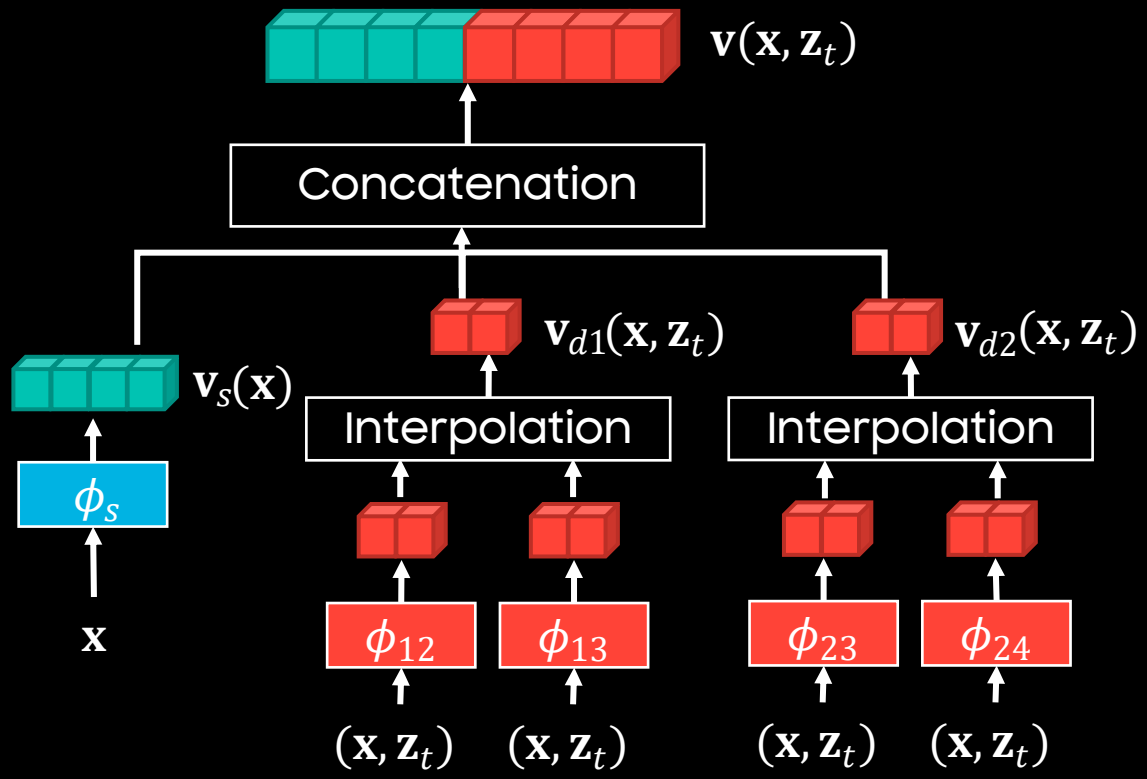


Grid representation

: Static feature vector

: Dynamic feature vector

Feature extraction



04 | Method

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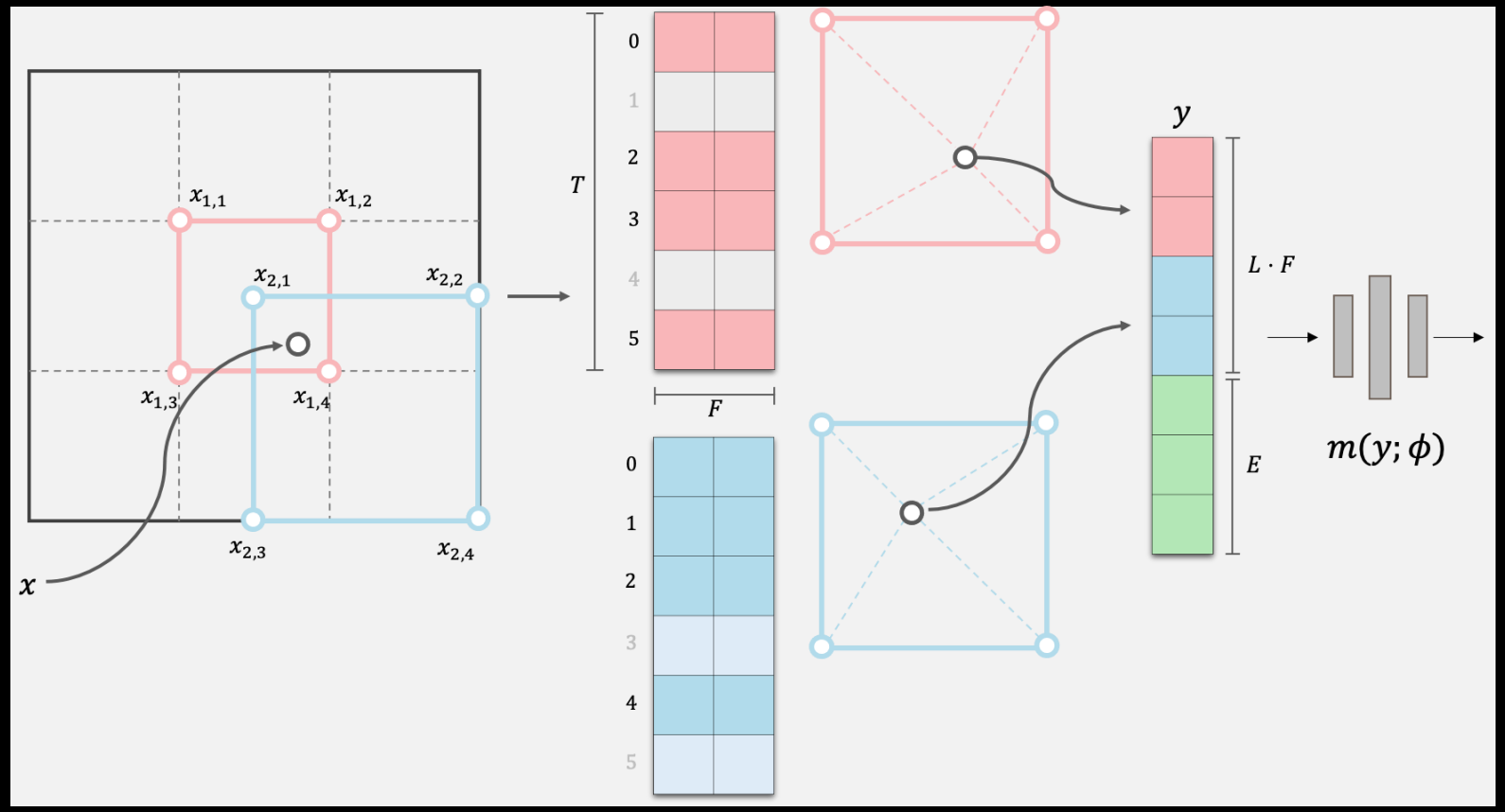
Neural representation

Grid representation

Use static and dynamic features via Hashgrids



Multi-resolution Hash Grid from InstantNGP (SIGGRAPH 2022)

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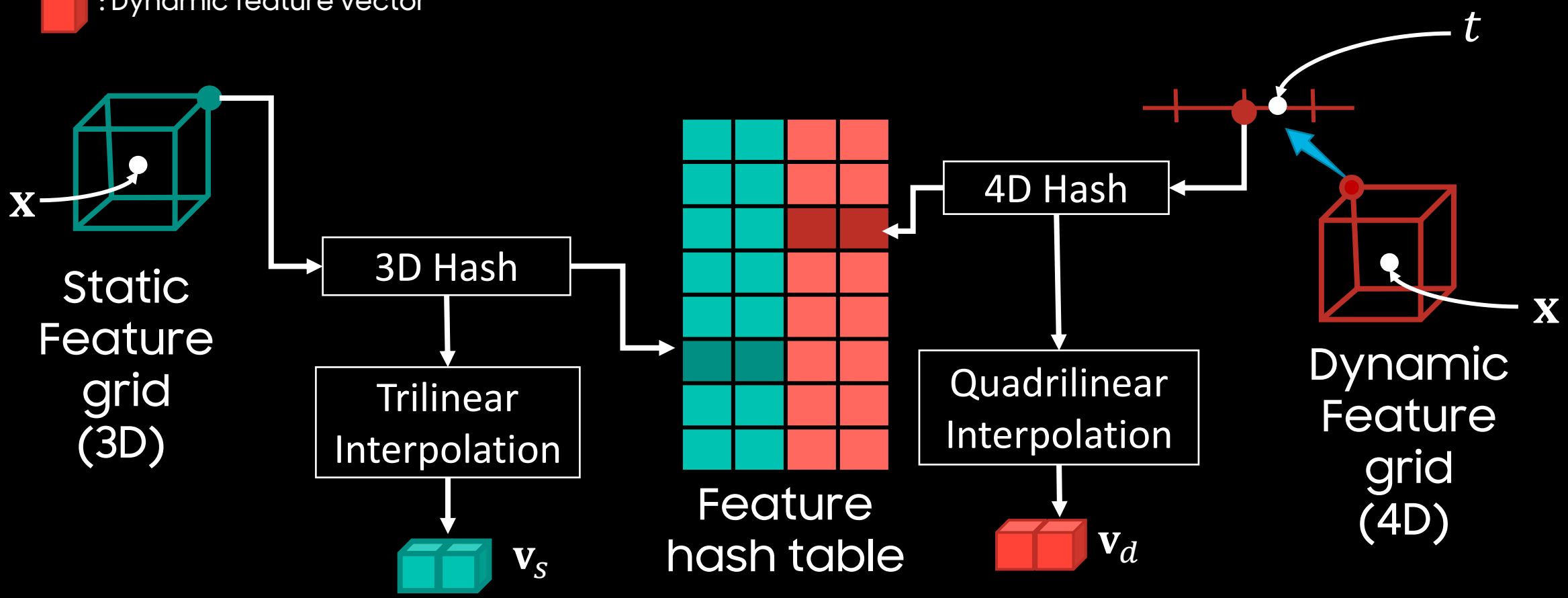
Grid representation

Use static and dynamic features via Hashgrids

: Static feature vector

: Dynamic feature vector



04 | Method

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Smoothness Term

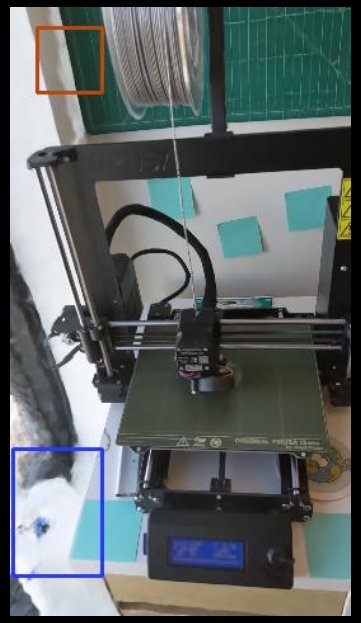
Simple assumption for partially observable points

- Regularization between two adjacent time frames
- Unobserved regions remain static

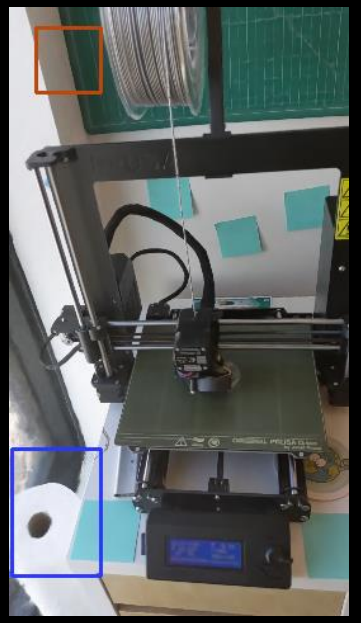
$$||\mathrm{v}_d(\mathbf{x}, \mathbf{z}_t) - \mathrm{v}_d(\mathbf{x}, \mathbf{z}_{t+1})||_2$$

Smoothness on the

FEATURE SPACE!



w/o Smooth



w/ Smooth

GT

04 | Method

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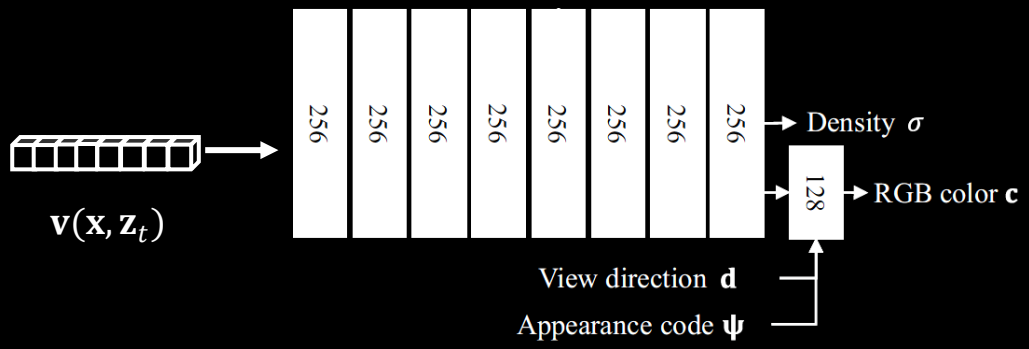
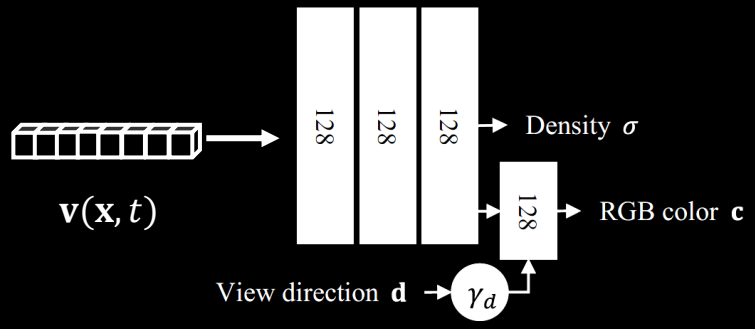
Template NeRF

Neural Representation: Based on HyperNeRF



Grid Representation: Based on InstantNGP



Loss function

Rendered Image

GT

$$L_{rgb} = \|\mathbf{C}_{\mathbf{Est}} - \mathbf{C}_{\mathbf{GT}}\|^2$$

$$L_{smooth} = \|\mathrm{v}_d(\mathbf{x}, \mathbf{z}_t) - \mathrm{v}_d(\mathbf{x}, \mathbf{z}_{t+1})\|_2$$

$$L = L_{rgb} + \lambda L_{smooth}$$

Experimantal Results

05 | Results

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Neural Representation

D-NeRF Dataset

Method	PSNR ↑	SSIM ↑	LPIPS ↓	AVG ↓
D-NeRF	30.43	0.95	0.07	0.02
TiNeuVox-B	<u>32.67</u>	<u>0.971</u>	0.041	<u>0.016</u>
Ours-NN (w/o smooth)	30.18	0.963	<u>0.038</u>	0.019
Ours-NN (w/ smooth)	**32.73**	**0.974**	**0.033**	**0.014**

05 | Results

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Neural Representation

HyperNeRF Dataset

Method	vrig		interp	
	PSNR↑	MS-SSIM↑	PSNR↑	MS-SSIM↑
NSFF	**26.33**	**0.916**	25.80	0.883
Nerfies	22.23	0.803	28.47	0.939
HyperNeRF	22.38	0.814	**29.00**	**0.945**
Ours-NN	<u>24.35</u>	<u>0.867</u>	<u>28.67</u>	<u>0.940</u>

DyNeRF Dataset

Method	PSNR↑
NV	22.8
LLFF	23.24
DyNeRF	<u>29.58</u>
Ours-NN	**29.88**

05 | Results

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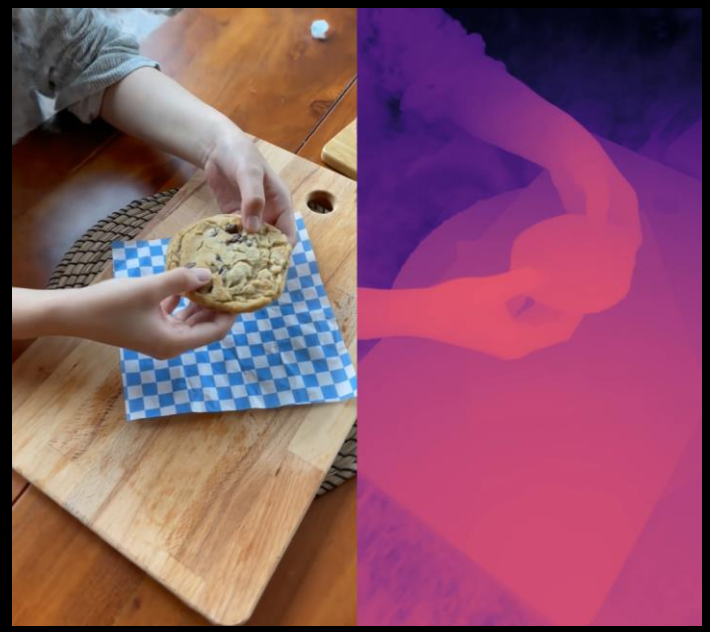
Neural Representation



05 | Results

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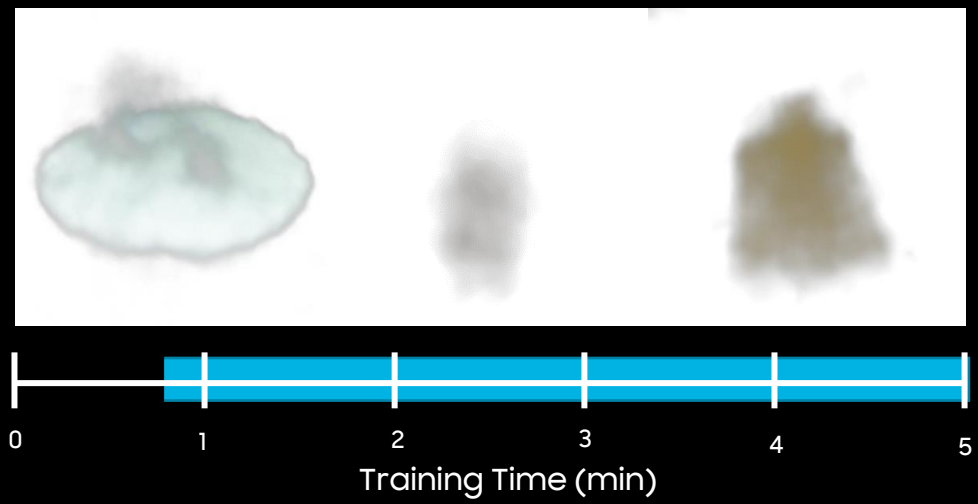
Grid Representation

D-NeRF Dataset

Method	Train time	PSNR↑	SSIM↑	LPIPS↓	AVG↓
NDVG-half	23min	27.15	0.857	**0.048**	0.033
TiNeuVox-S	8min	**30.75**	0.956	0.067	**0.023**
Ours-grid	1min	26.77	0.933	0.107	0.039
Ours-grid	5min	29.73	<u>0.961</u>	0.063	0.024
Ours-grid	8min	<u>29.84</u>	**0.962**	<u>0.062</u>	**0.023**



05 | Results

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Grid Representation

D-NeRF Dataset

TinueVox-S

Ours-grid

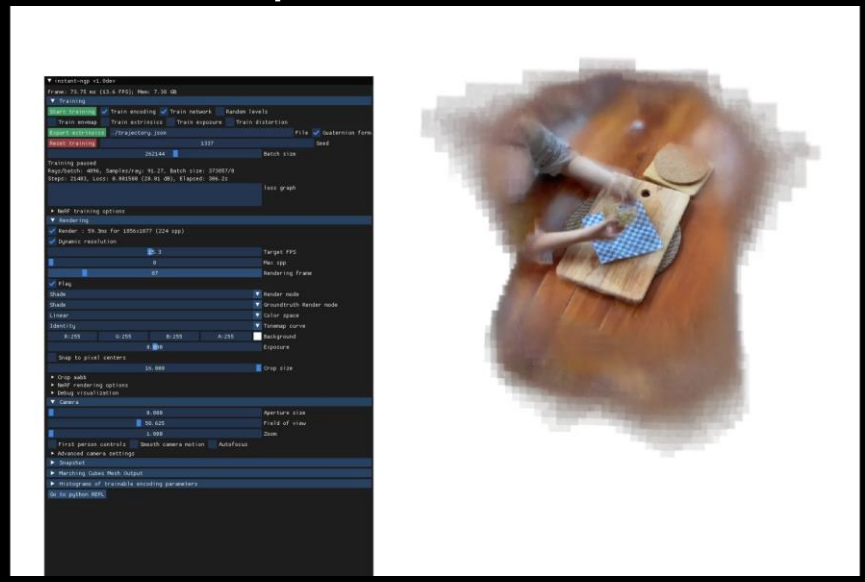
Conclusion

- ✓ A **simple yet powerful** feature representation for dynamic NeRF

Neural representation

- Good quality
- Small-sized models
- Hours of training

Grid representation



- Fast training
- Real-time applications

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Thank you

Join us at the Poster session!

Project Page
https://sungheonpark.github.io/tempinterpnerf

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