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NeRFLight: Fast and Light Neural Radiance Fields using a Shared Feature Grid

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Motivation

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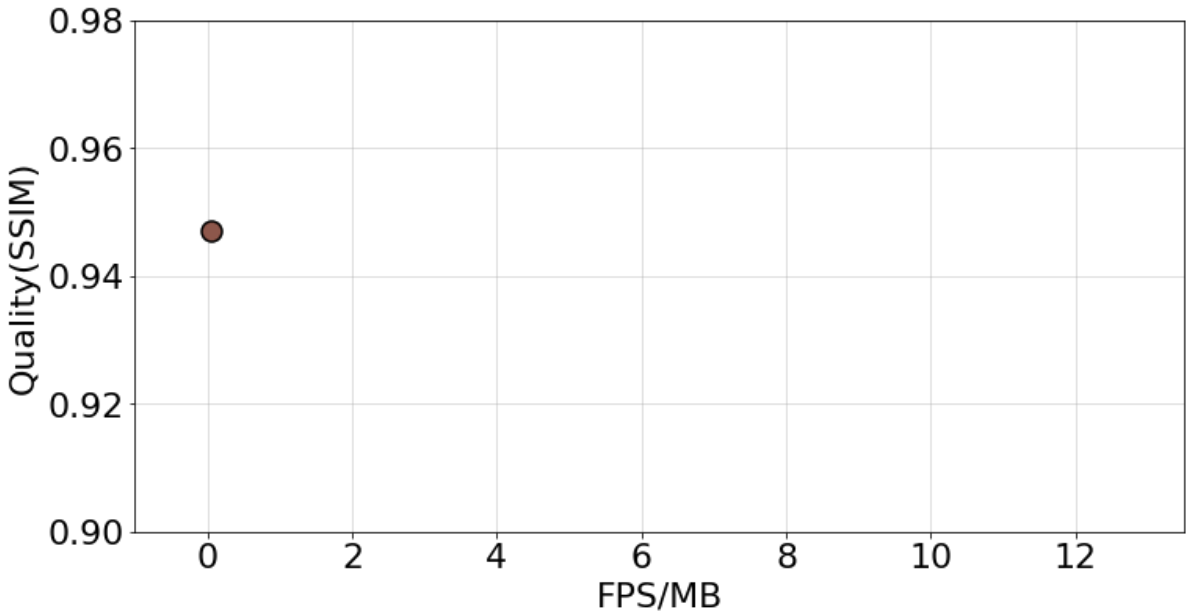
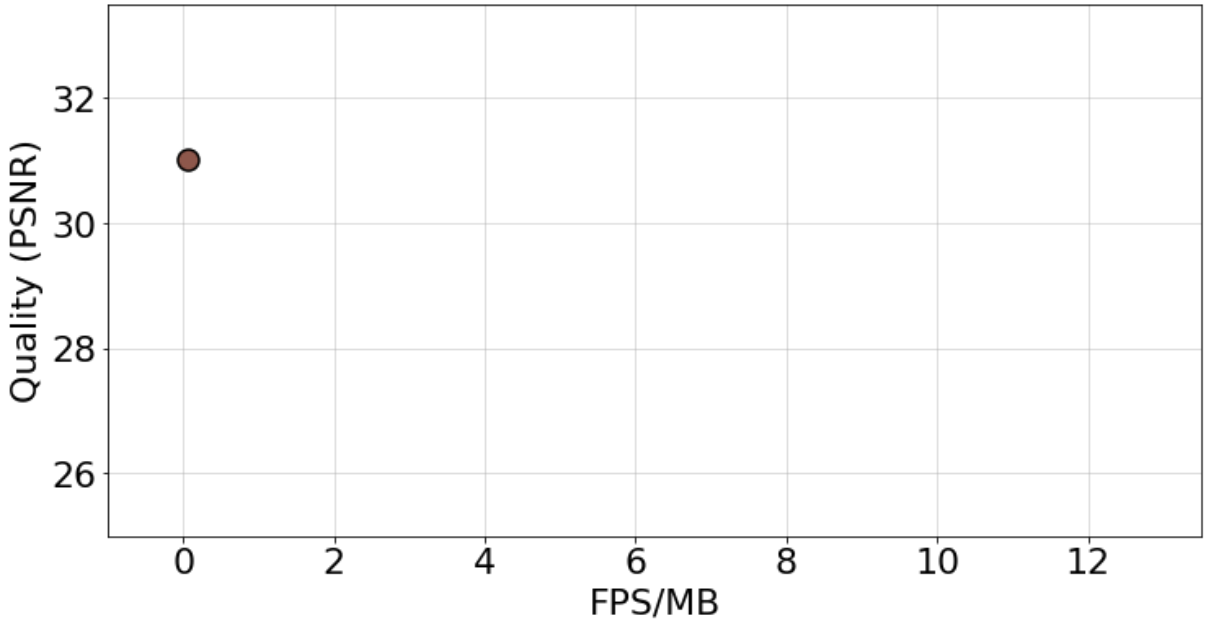
NeRF proposes a new compact representation for 3D scenes but it is slow at inference





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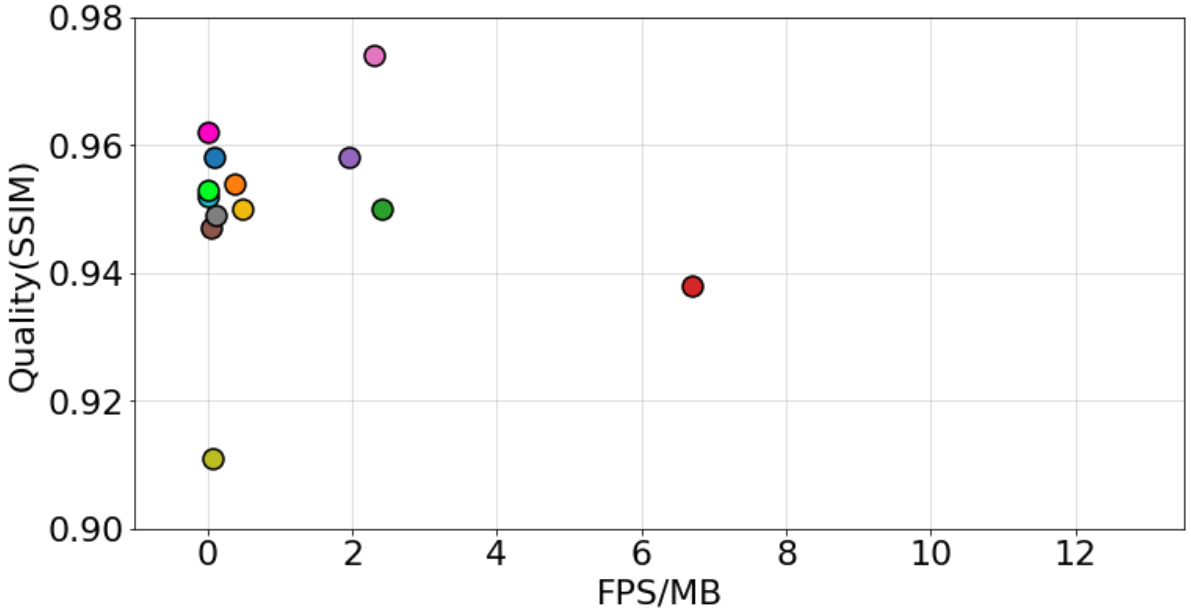
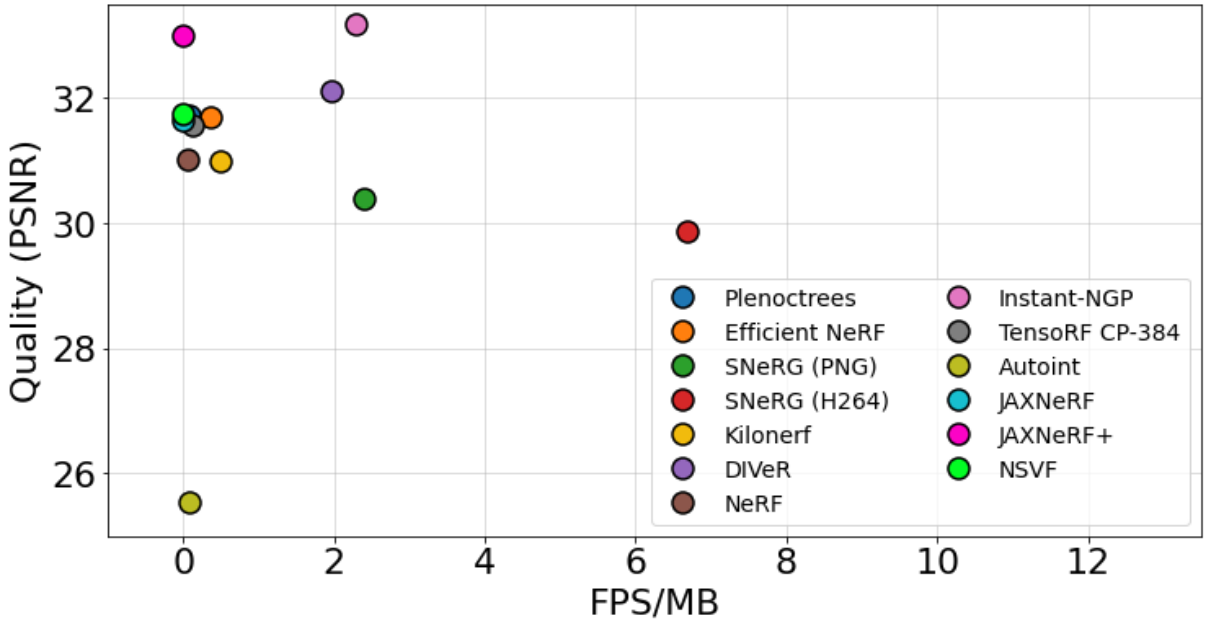
Compact NeRF methods are slow at inference
Fast NeRF methods require larger models





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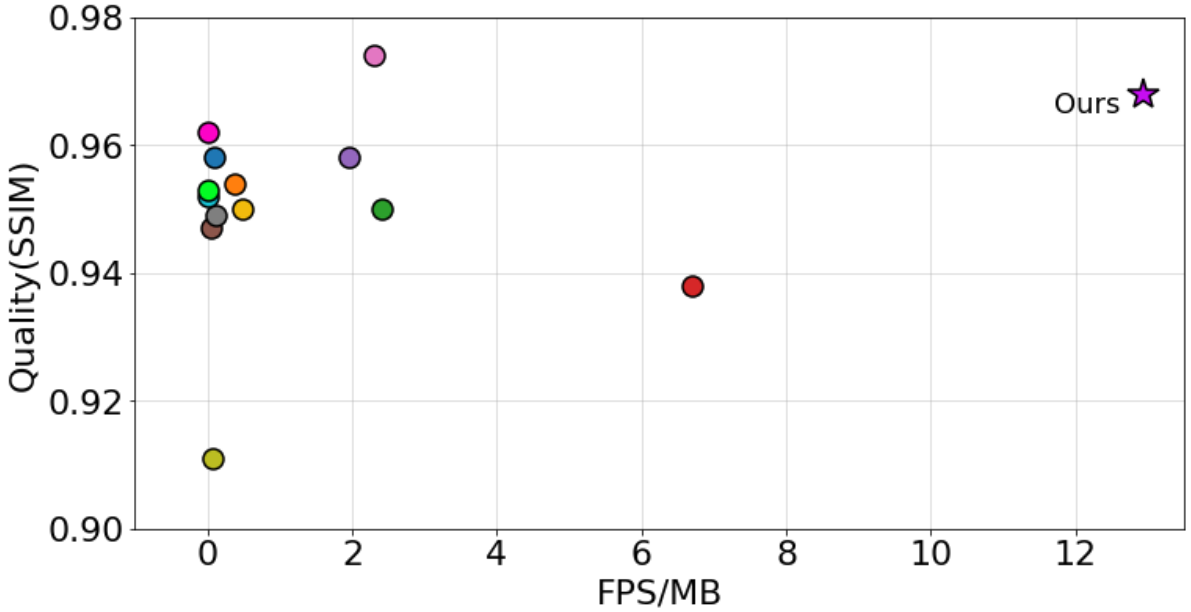
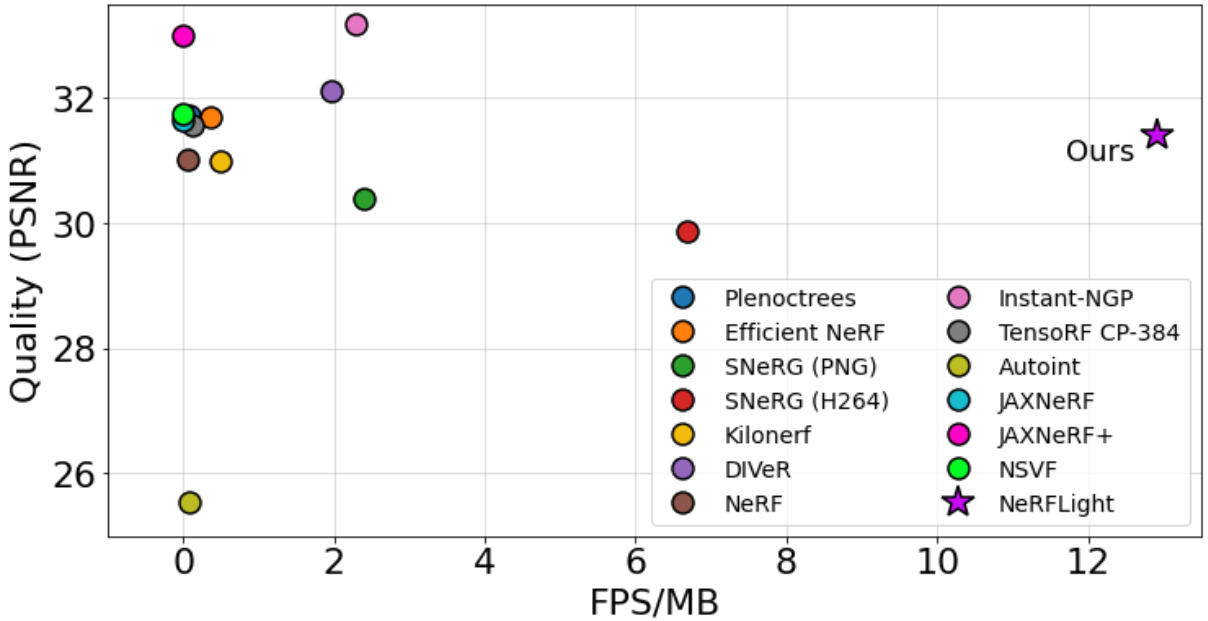
NeRFLight achieves an improvement of more than 2x in FPS/MB!





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Method

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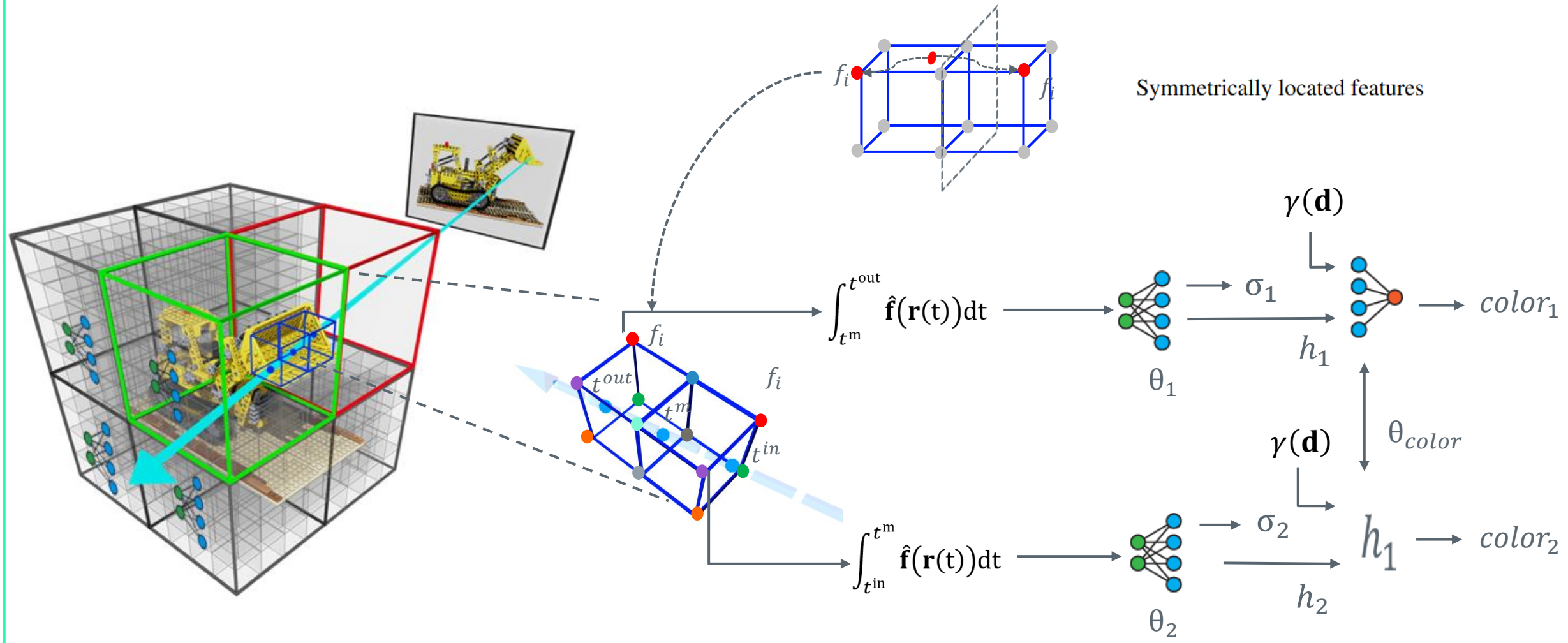
Divide-and-Conquer: split the scene in 8 regions with a shared feature grid



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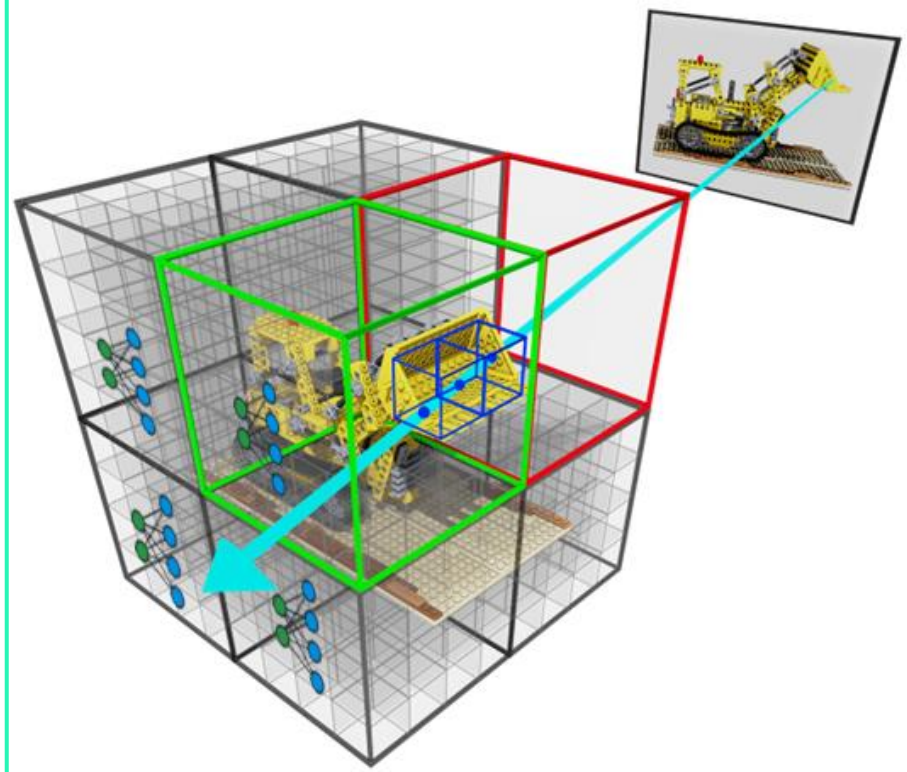
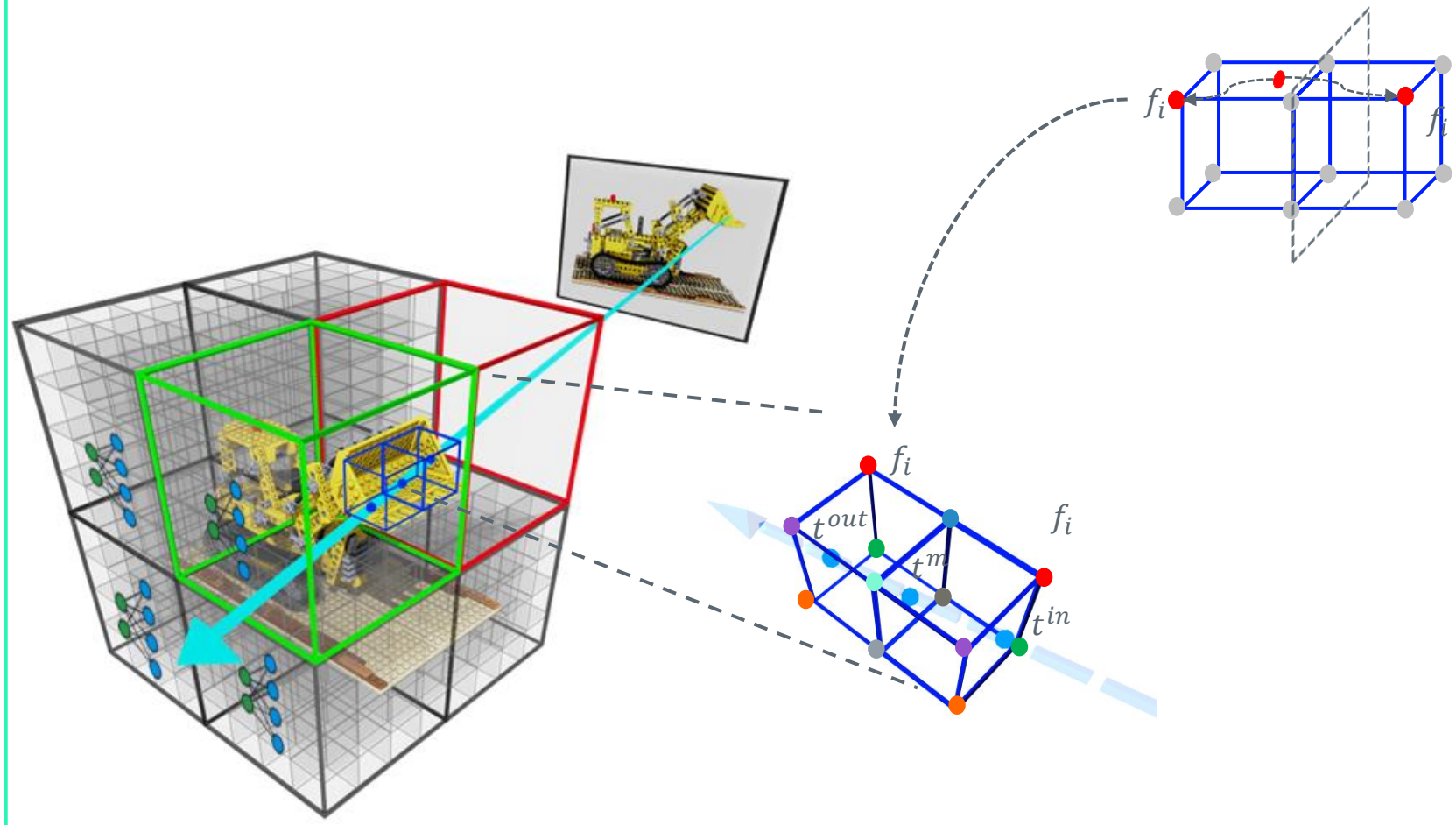
1. Divide the scene in 8 regions.



1. Divide the scene in 8 regions.

2. Use a share feature grid and arrange the features symmetrically.



Symmetrically located features

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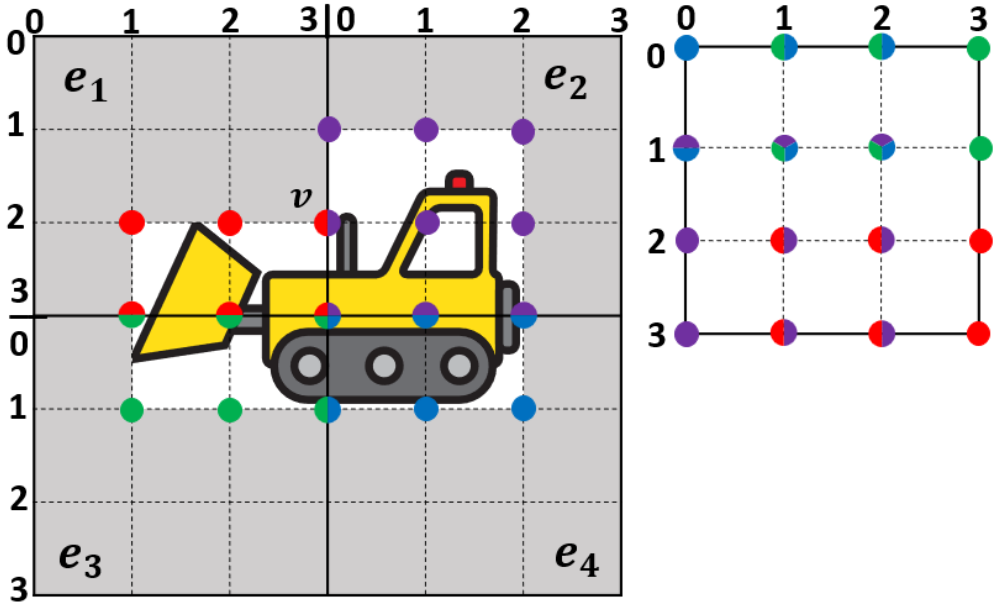
1. Divide the scene in 8 regions.

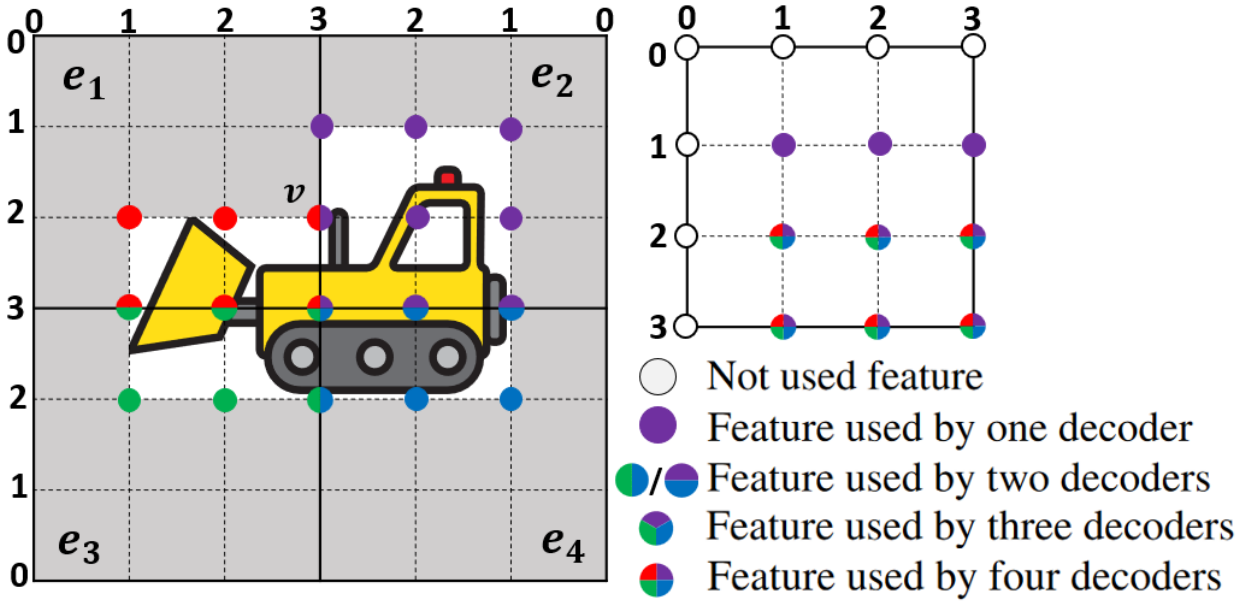
2. Use a shared feature grid and arrange the features symmetrically.

Benefits of using a symmetric grid:

1. Seamless reconstruction
2. Smaller model



Linear grid



Symmetric grid (ours)

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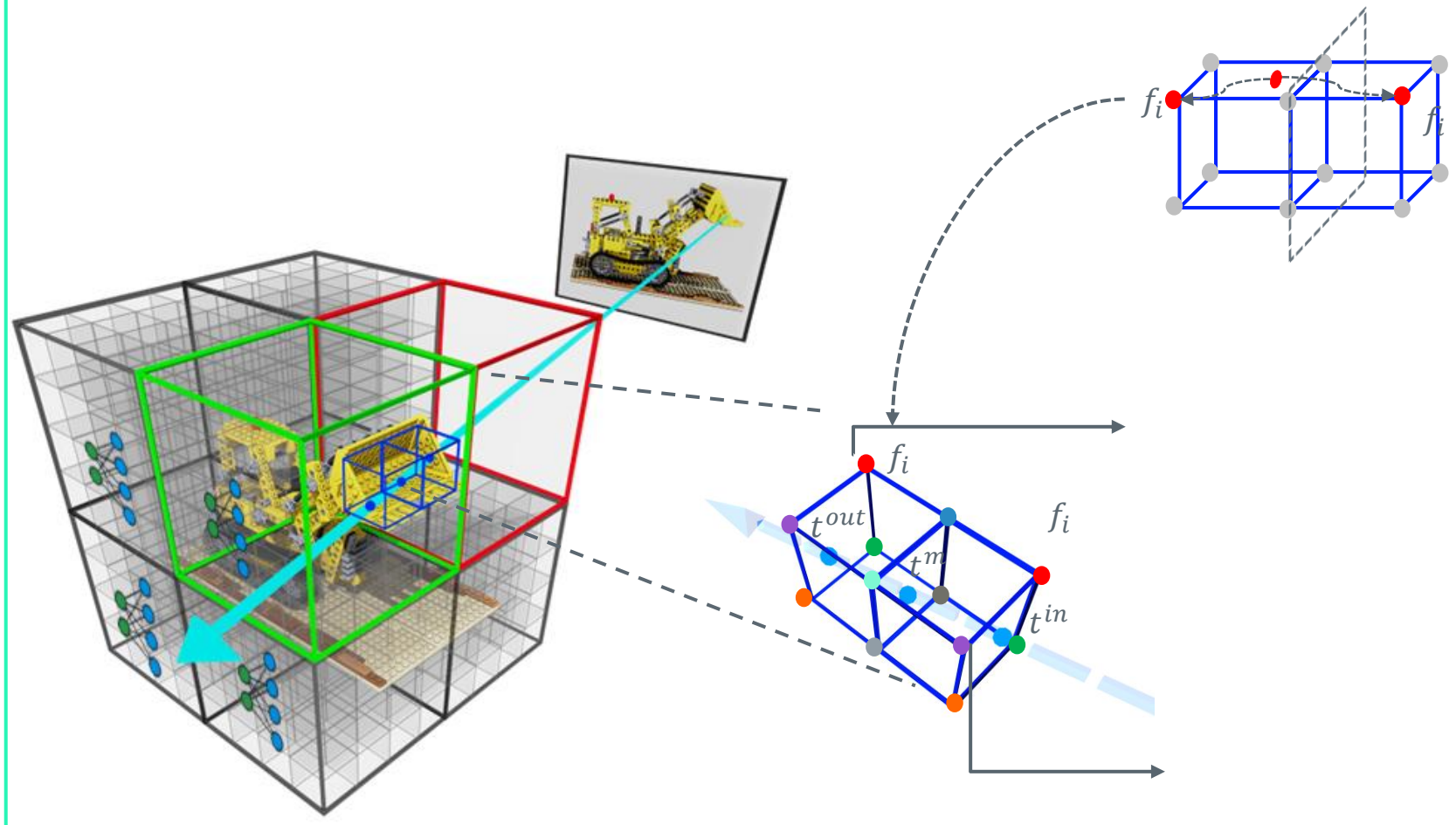
1. Divide the scene in 8 regions.

2. Use a shared feature grid and arrange the features symmetrically.



Symmetrically located features

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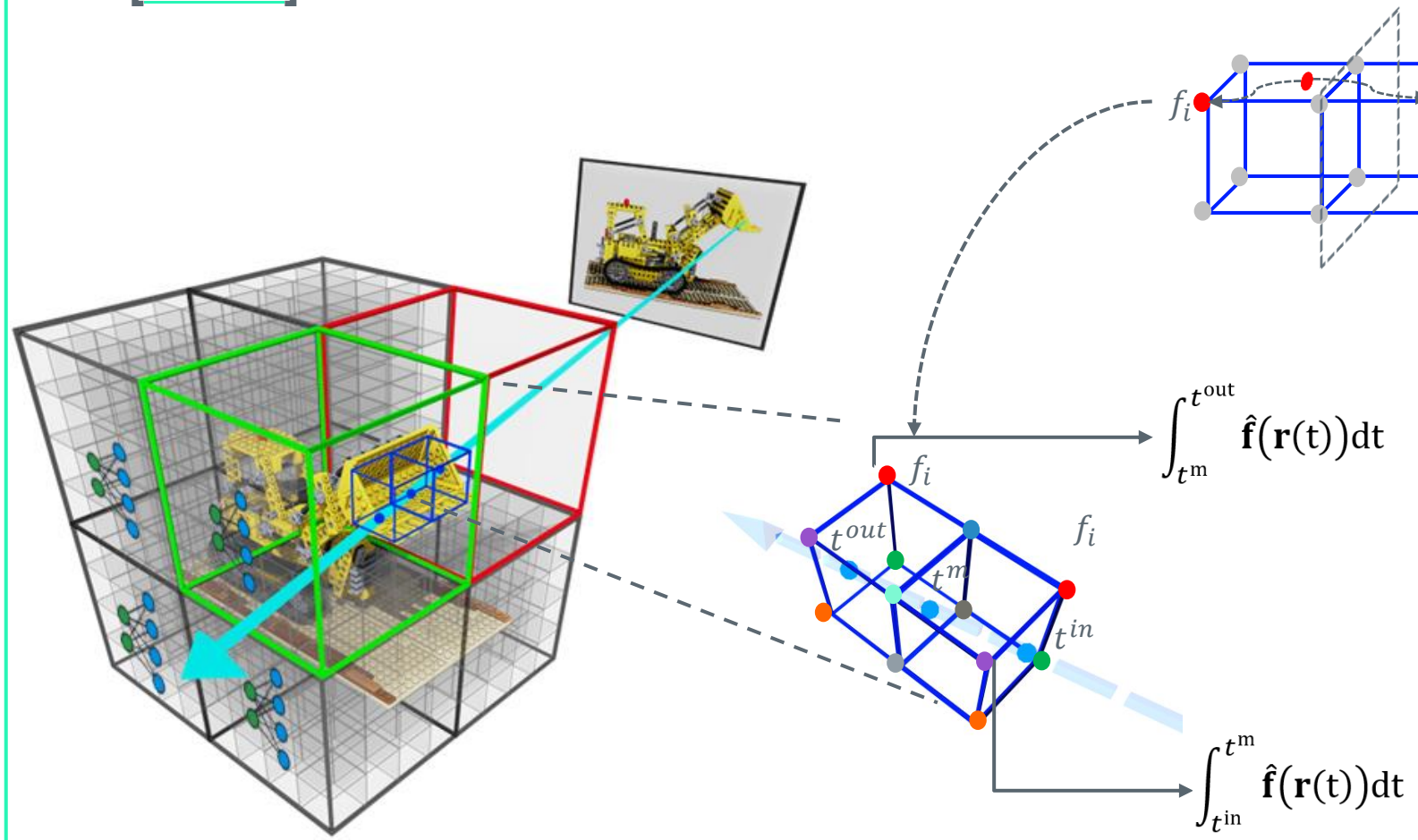
1. Divide the scene in 8 regions.
2. Use a shared feature grid and arrange the features symmetrically.

3. Apply volumetric integration of the features.

[DIVeR]



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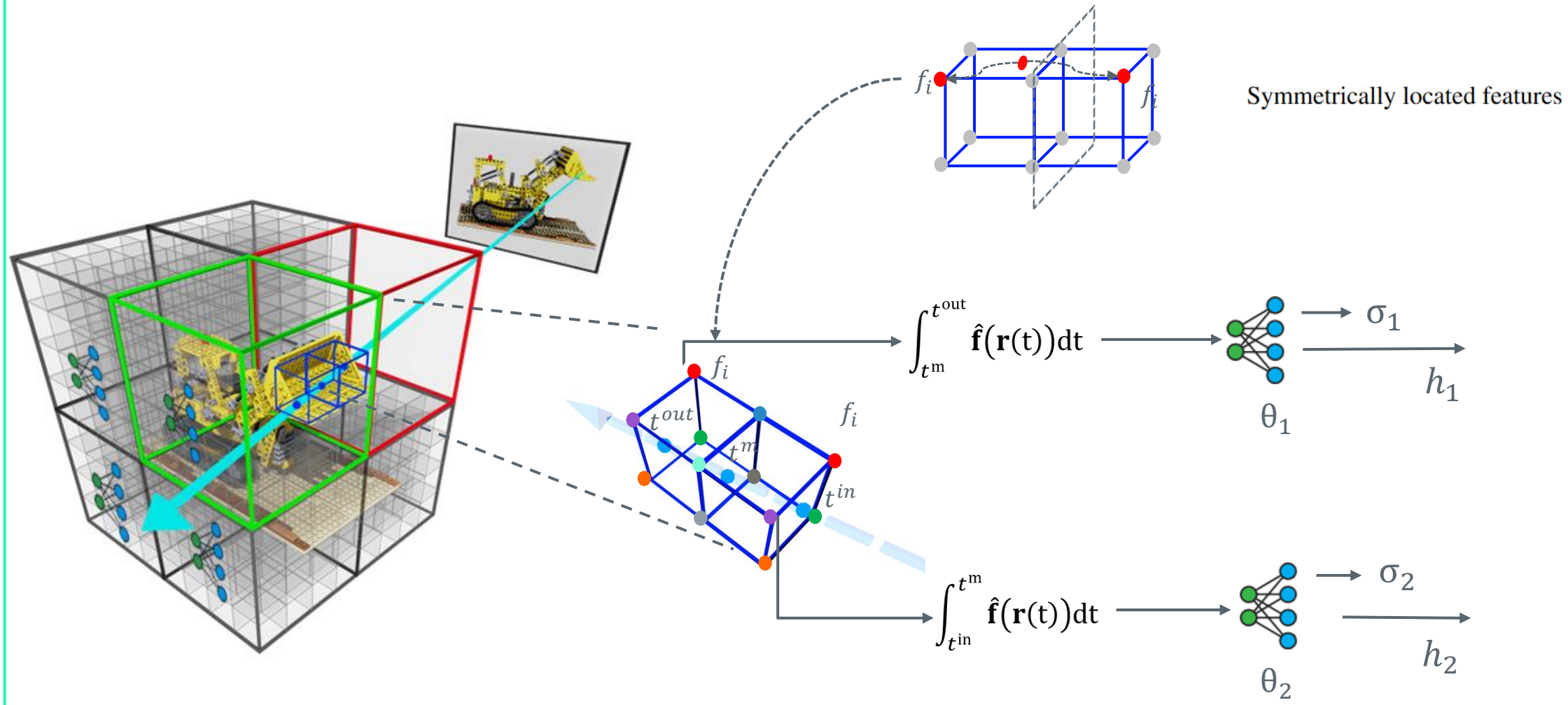
1. Divide the scene in 8 regions.
2. Use a shared feature grid and arrange the features symmetrically.
3. Apply volumetric integration of the features.

4. Evaluate region specific density decoders.



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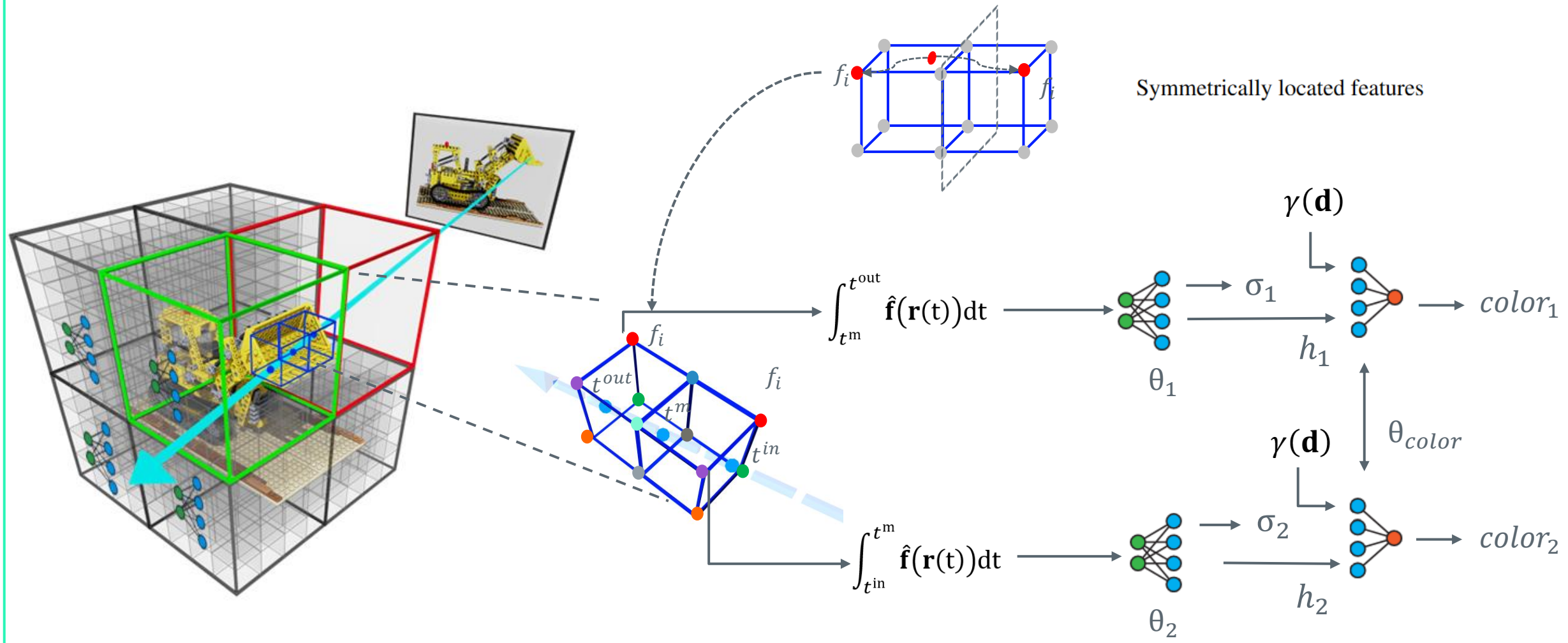
5. Evaluate color decoder.

1. Divide the scene in 8 regions.
2. Use a shared feature grid and arrange the features symmetrically.
3. Apply volumetric integration of the features.
4. Evaluate region specific density decoders.



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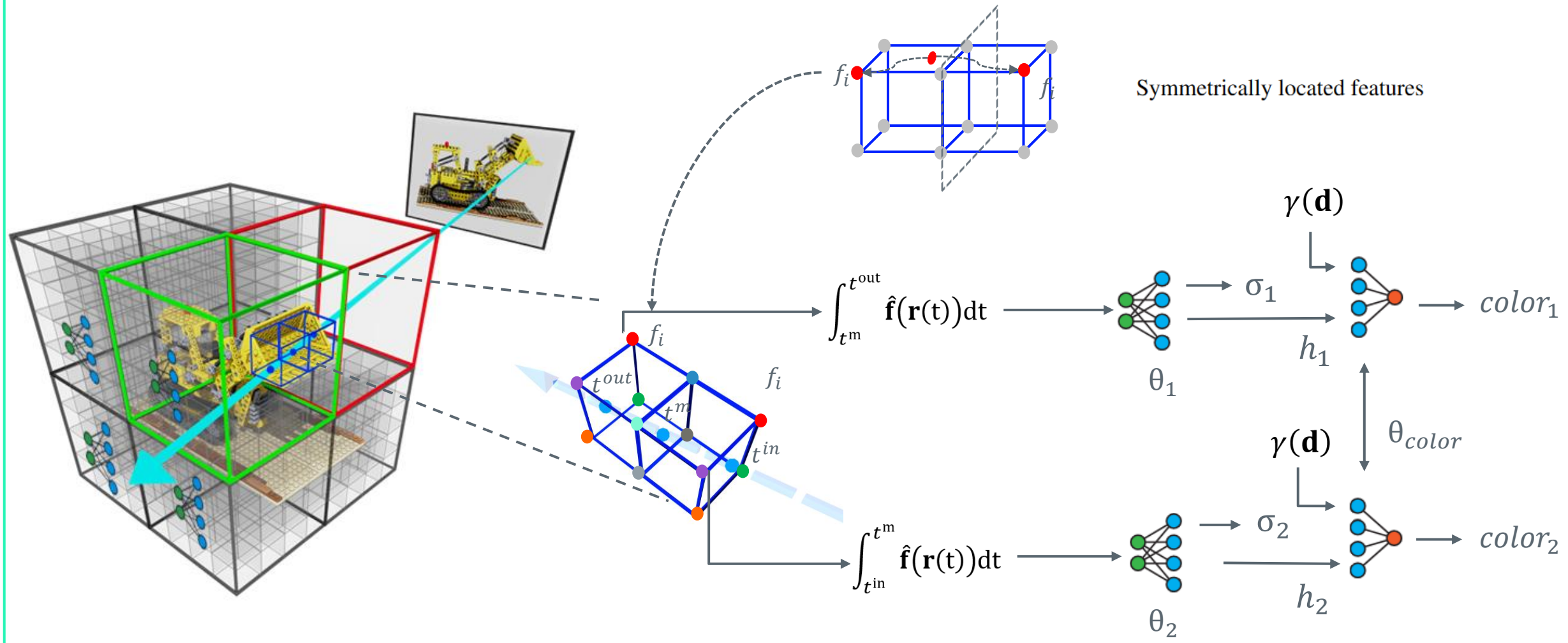
1. Divide the scene in 8 regions.
2. Use a shared feature grid and arrange the features symmetrically.
3. Apply volumetric integration of the features.
4. Evaluate region specific density decoders.
5. Evaluate color decoder.

6. Apply feature pruning and feature quantization (16 bits) (once the training is done).



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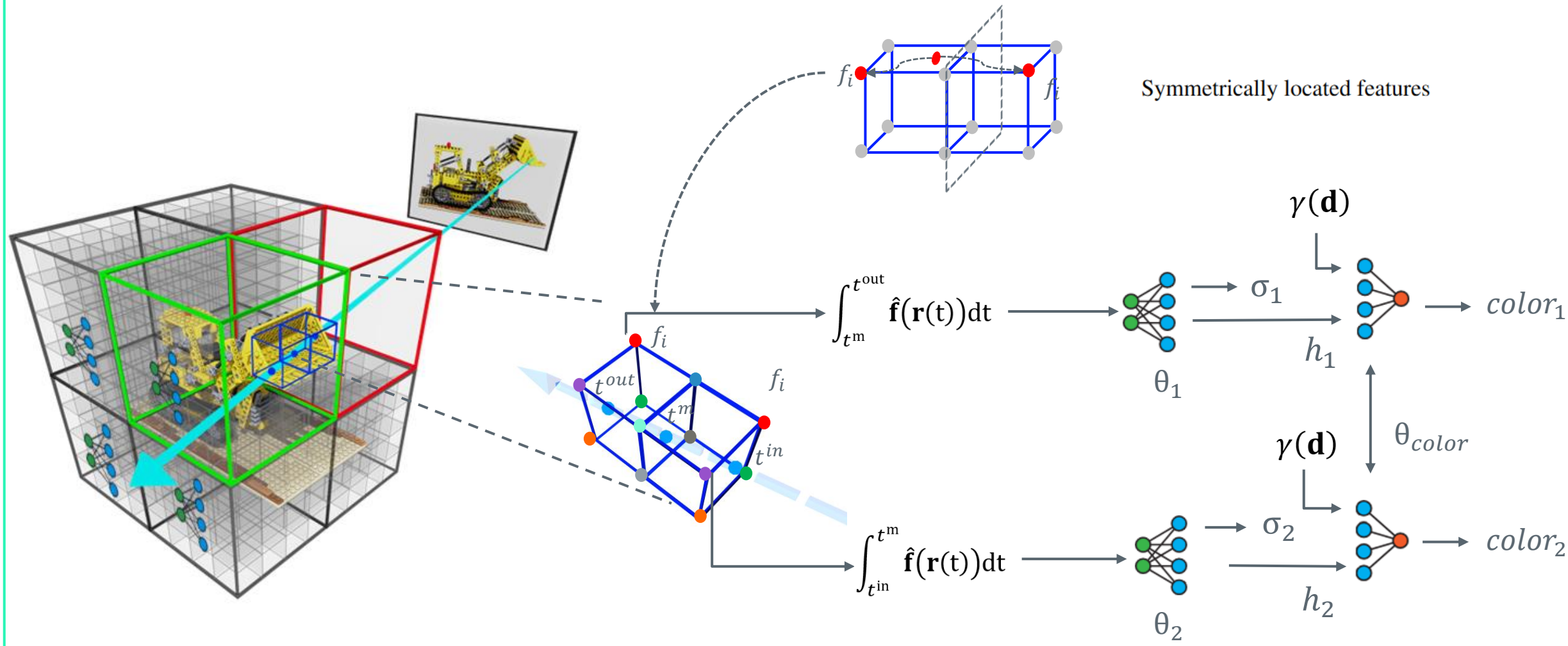

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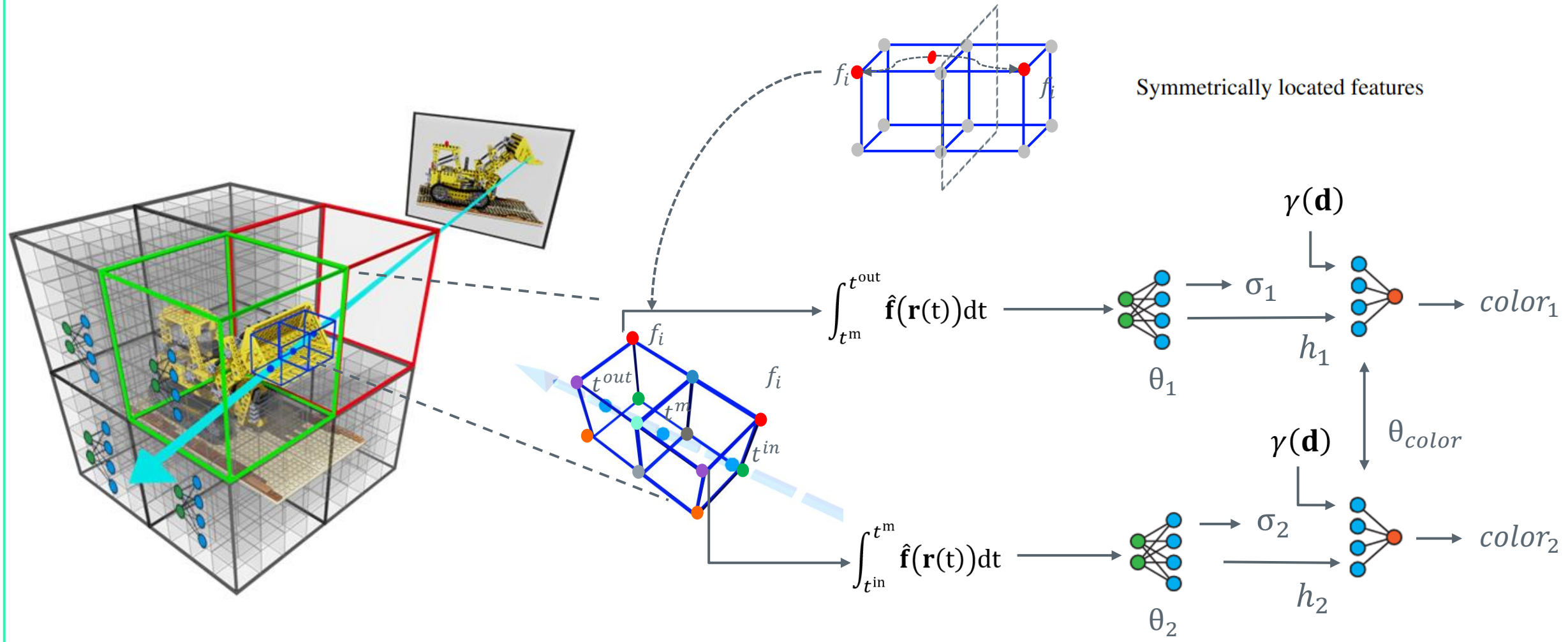

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Ablation

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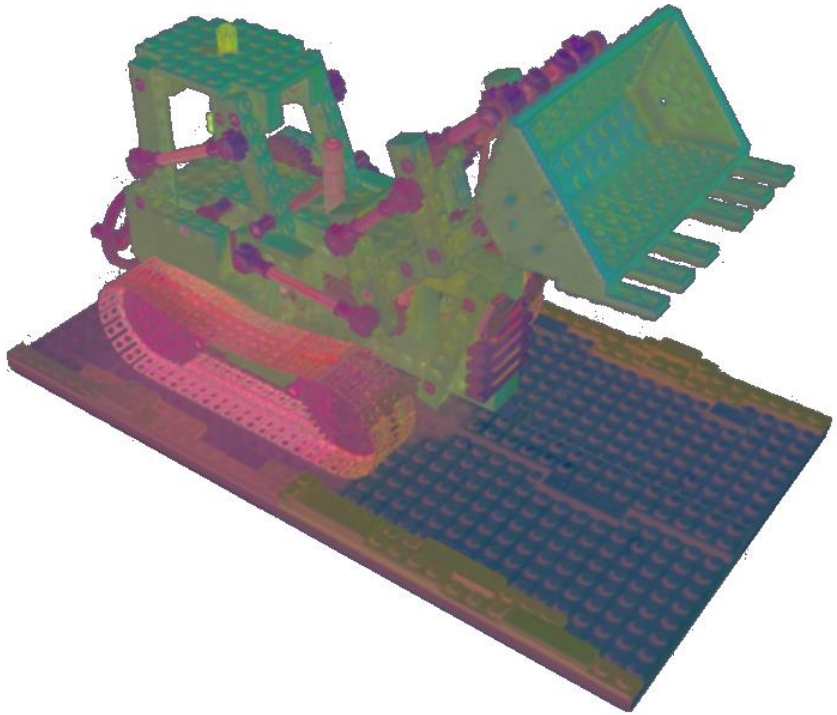
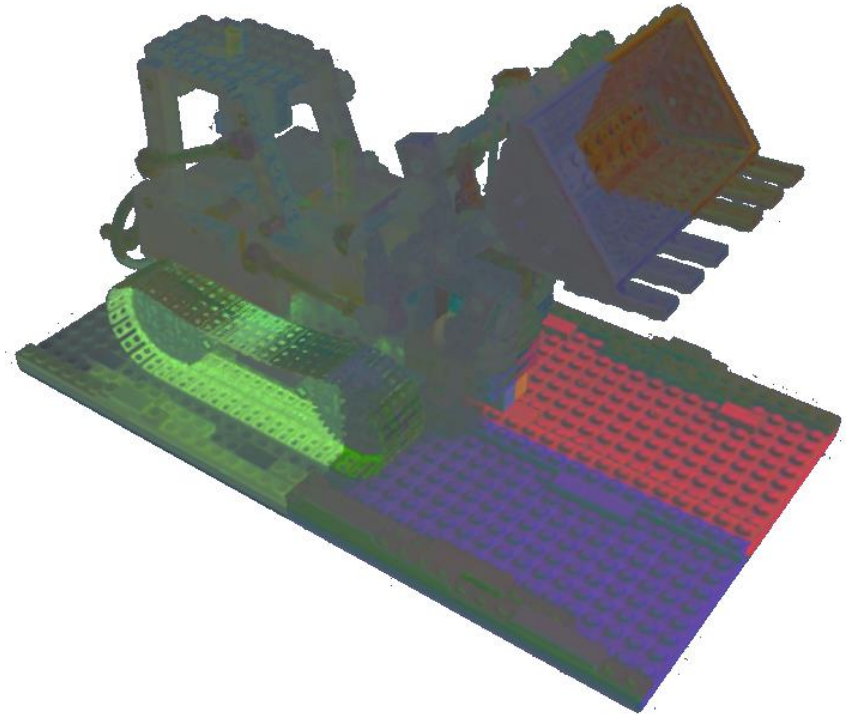
Ablation on symmetric grid: PCA of the outputs (h_i) of the density decoders. Symmetric grid achieves a continue feature space for the color decoder.



Symmetric grid (ours)



Linear grid

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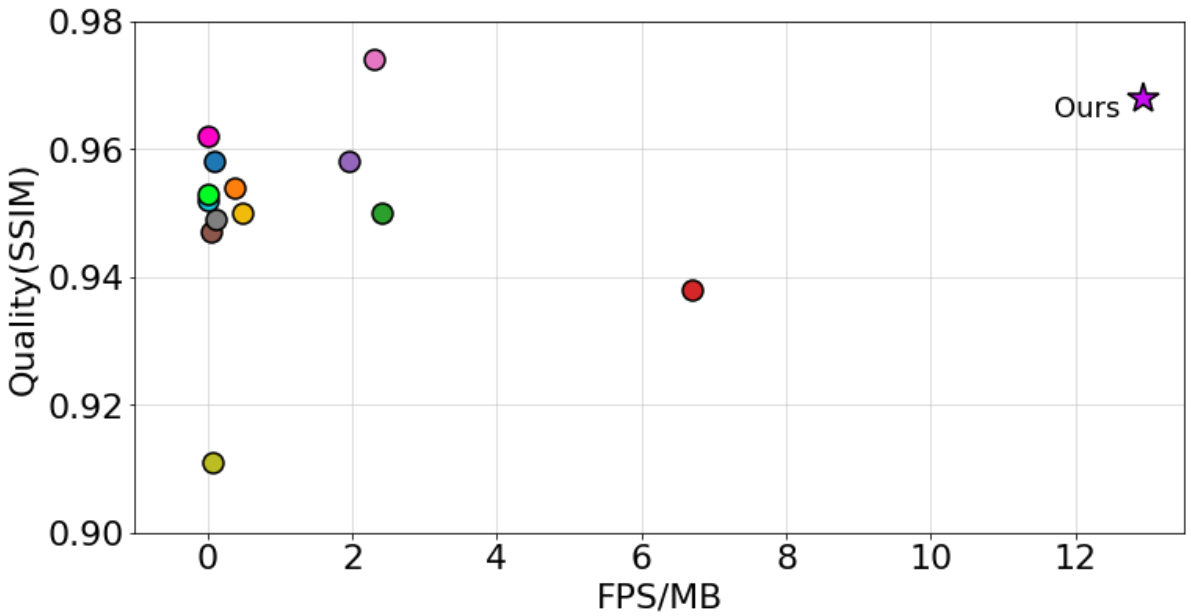
Ablation on symmetric grid: Qualitative results.
Symmetric grid produces a seamless reconstruction.

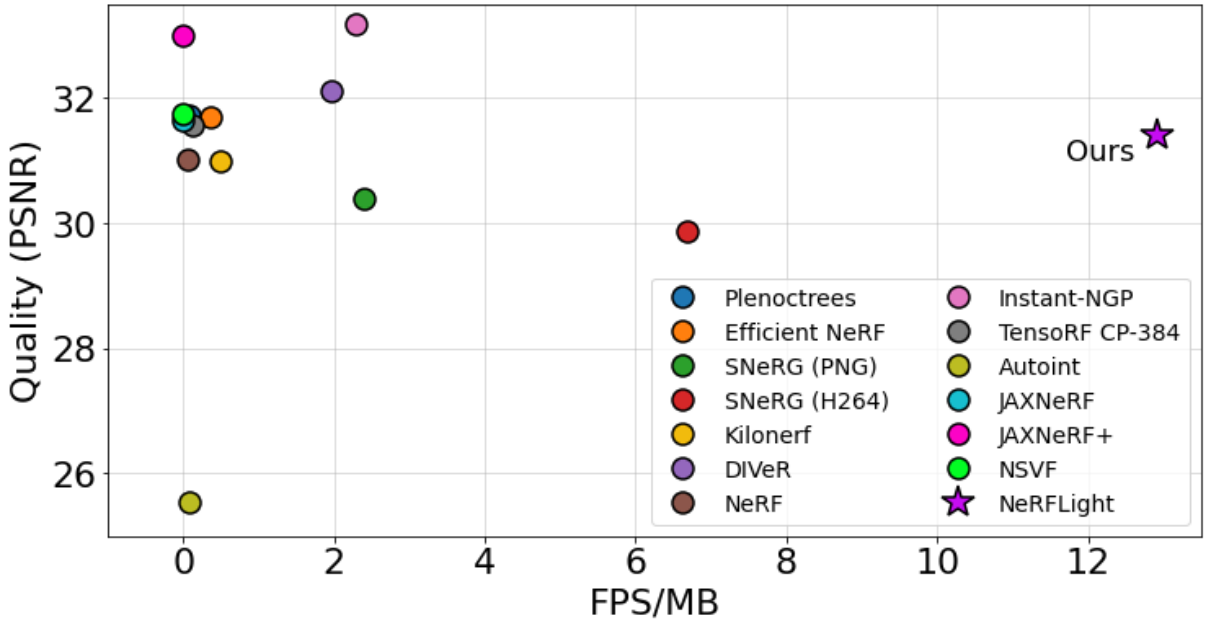
Symmetric grid (ours)

Linear grid

Results

Quantitative results (NeRF synthetic dataset)





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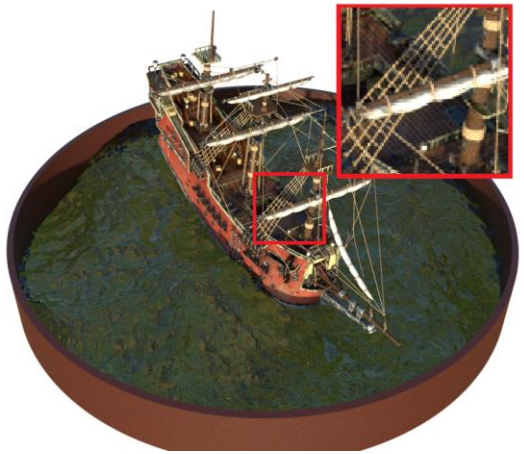
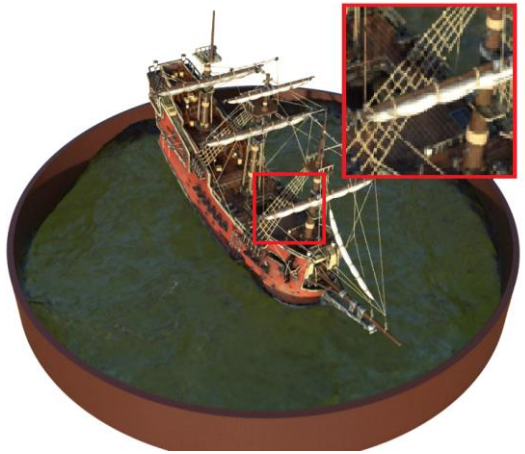
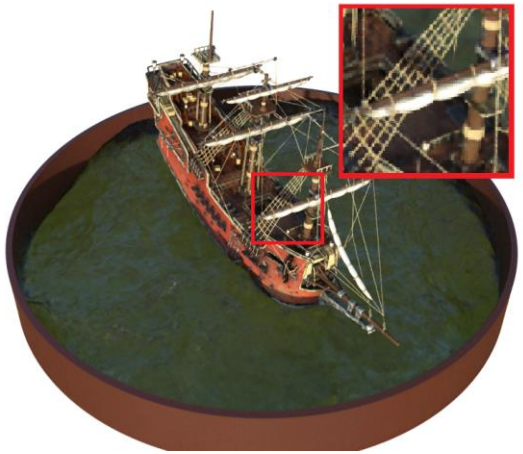
Qualitative results (NeRF synthetic dataset)



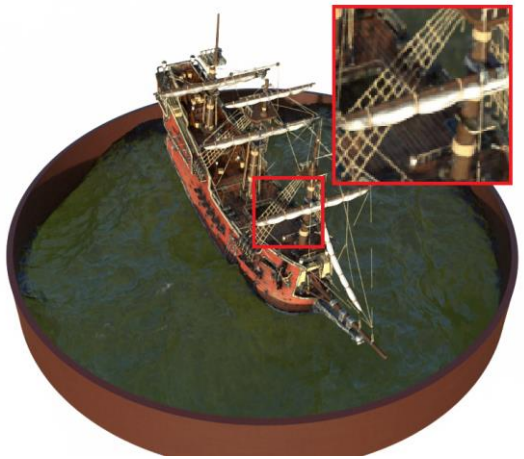
Ground truth



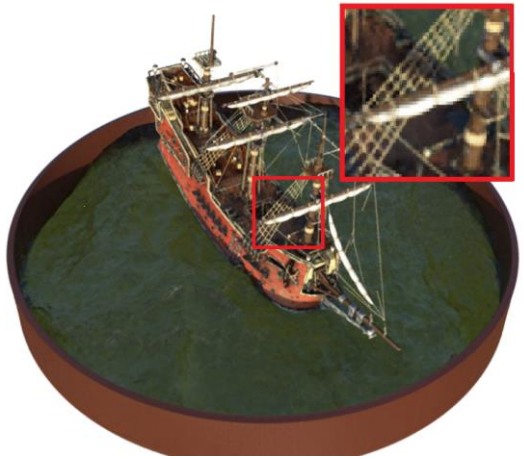
Instant-NGP



DIVeR



Tensor-RF



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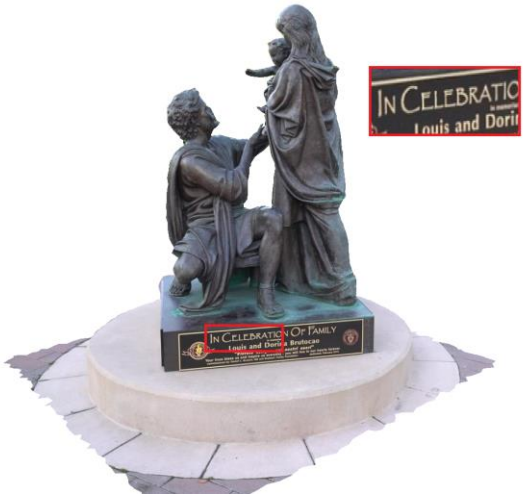
Qualitative results (Tanks and temples dataset)



Ground truth

Instant-NGP

DIVeR

Tensor-RF

NeRFLight

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Conclusions

- A NeRF architecture based on a **shared feature grid** providing a **light** and **fast** representation.
- A **symmetric** layout of the shared **feature grid** that favors a seamless reconstruction, **higher accuracy** and **reduces model size**.
- NeRF model with **highest frame rate** vs. **storage cost** ratio

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