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# Adaptive Incident Radiance Field Sampling and Reconstruction Using Deep Reinforcement Learning

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KAIST and CAD&CG

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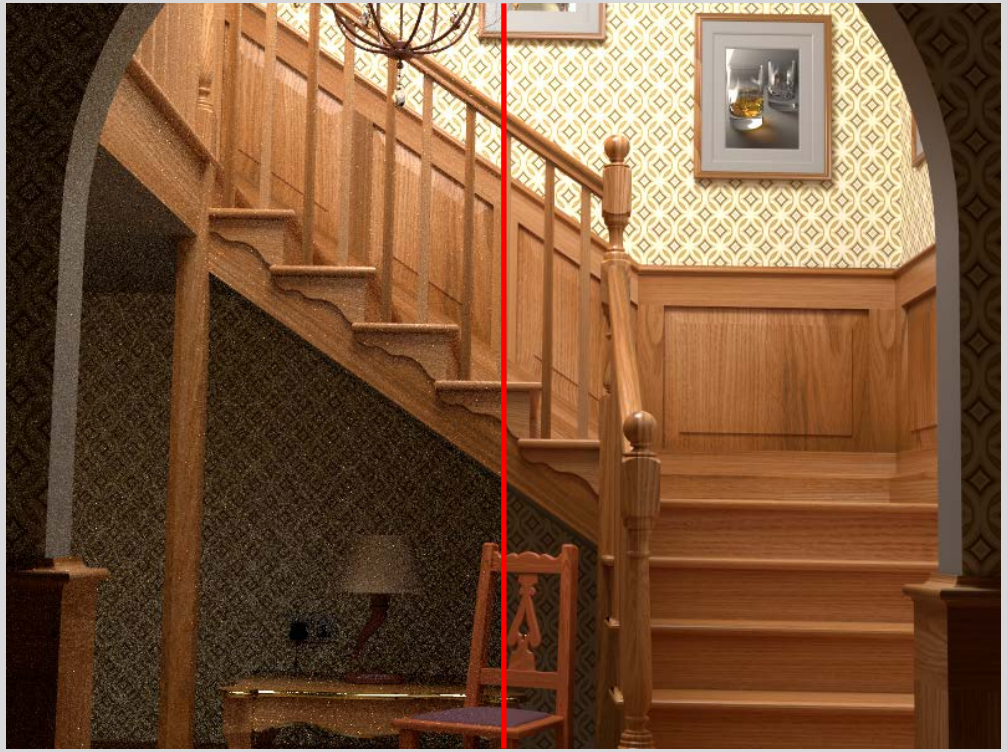
Articles 1-8

# Global Illumination



Filtering

- Animation, preview …

Path Guiding

- Design, Physical Simulation, Data Generation …

# Global Illumination

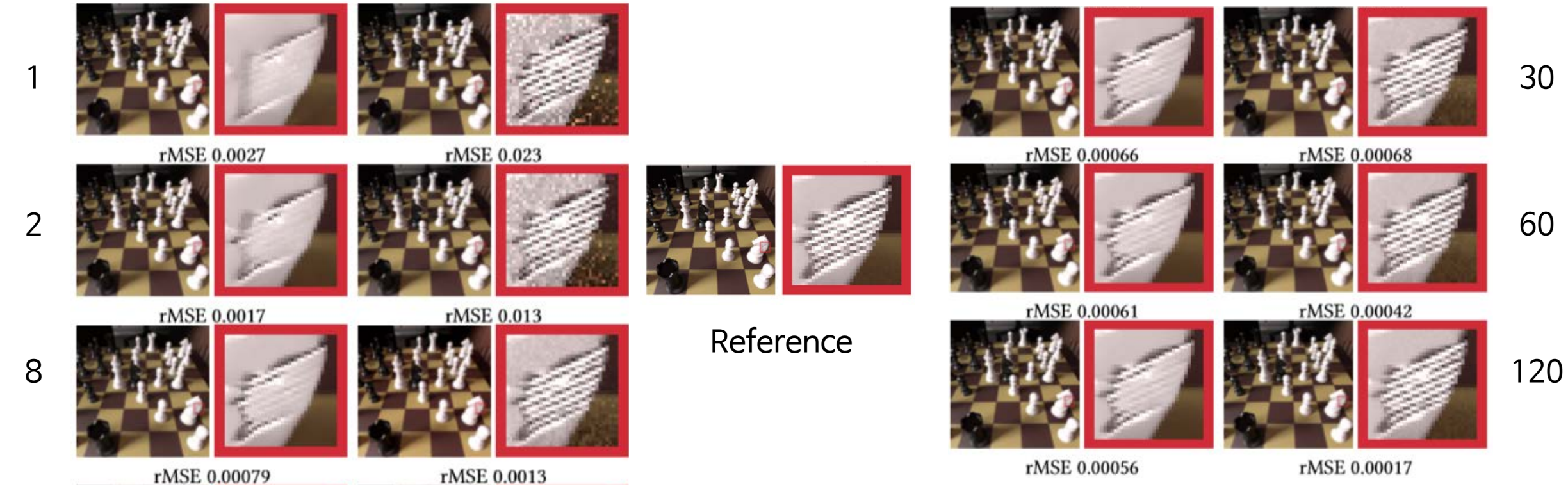
Filtering

- Animation, preview …

Path Guiding

- Design, Physical Simulation, Data Generation …

# Filtering V.S. Path Guiding



# Path Guiding – A Sampling Problem

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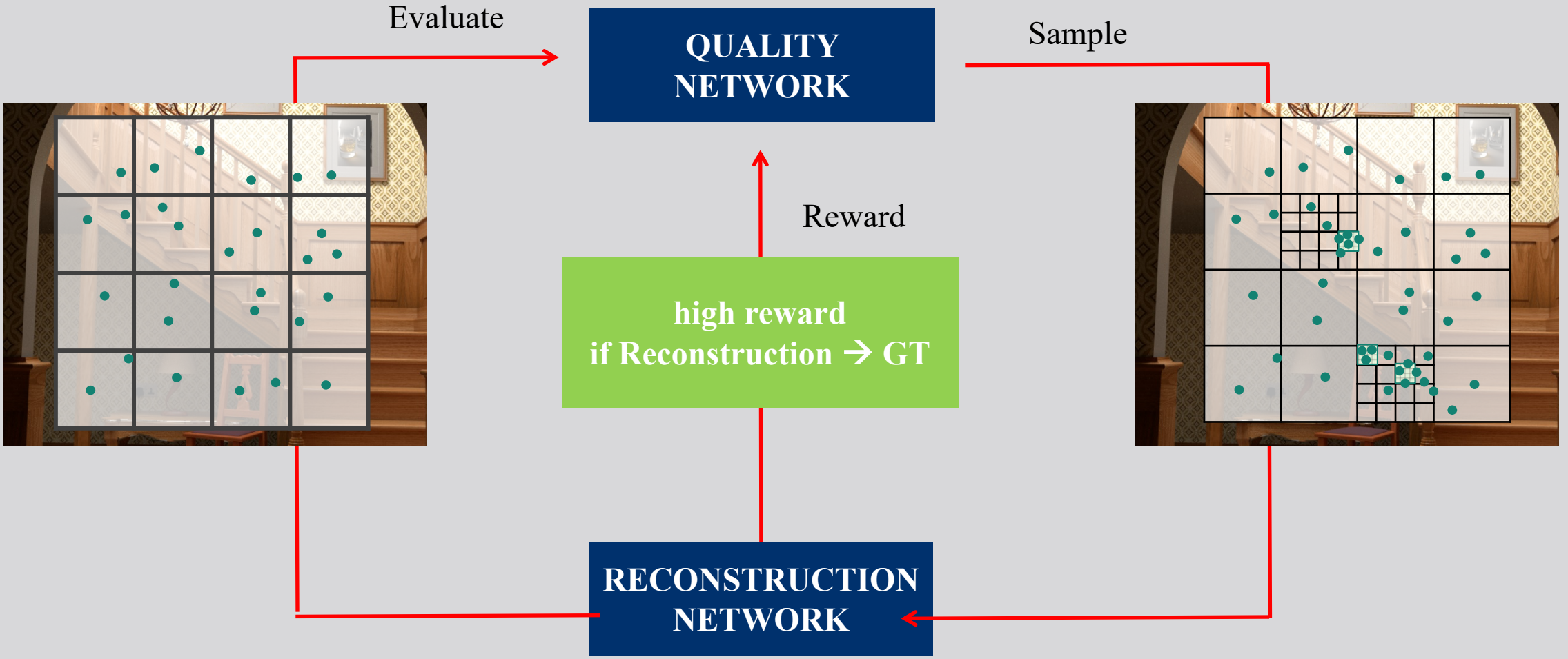
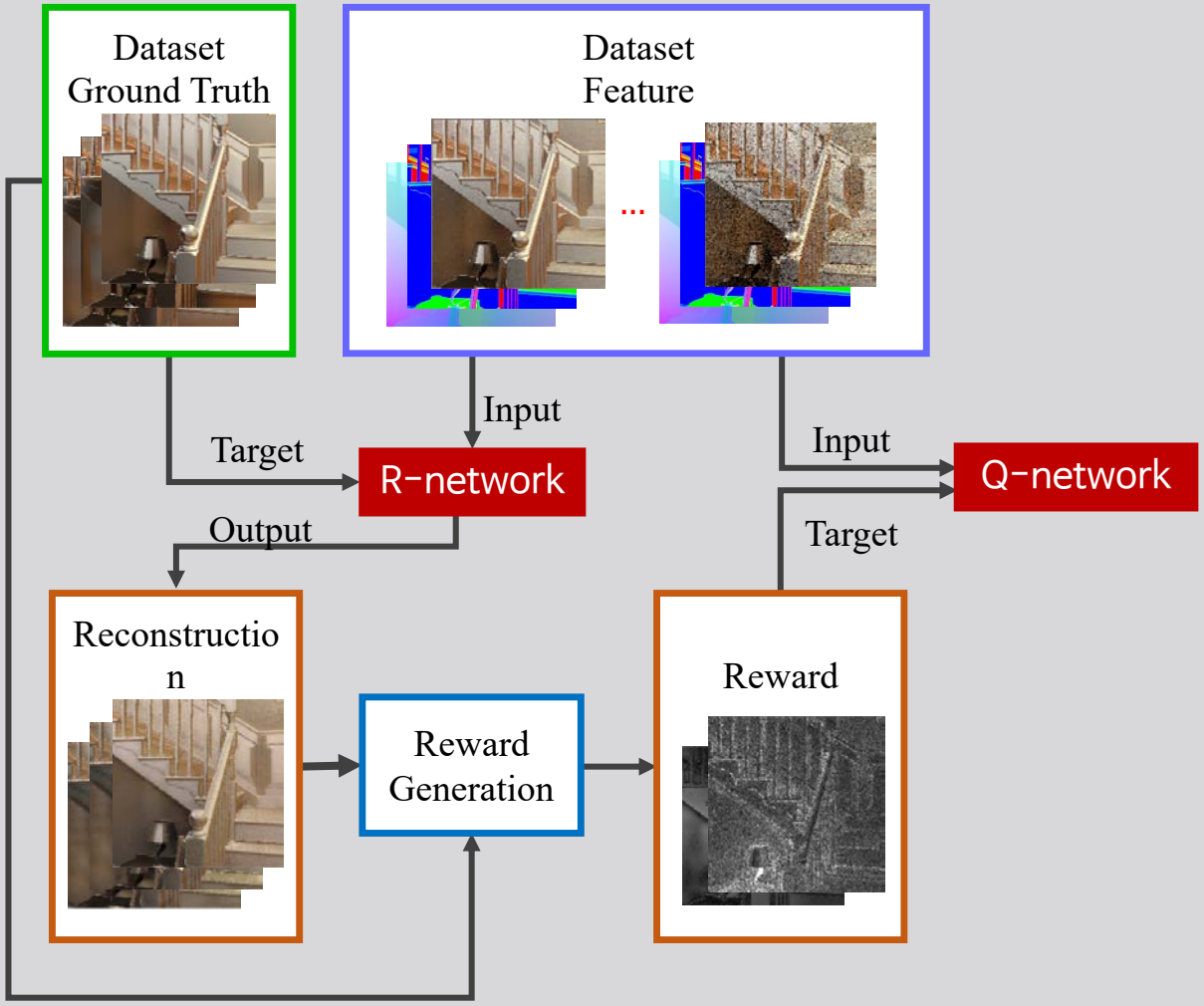
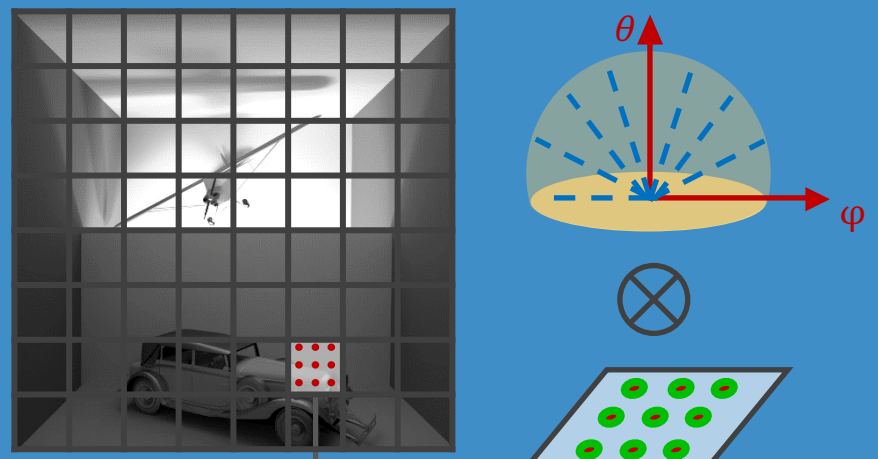


# Training R- and Q-networks

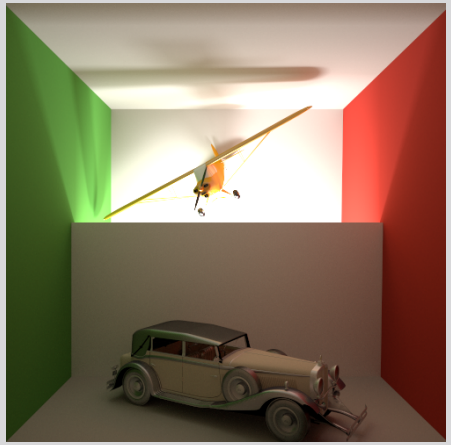


# Radiance Field Reconstruction using Deep Leaning

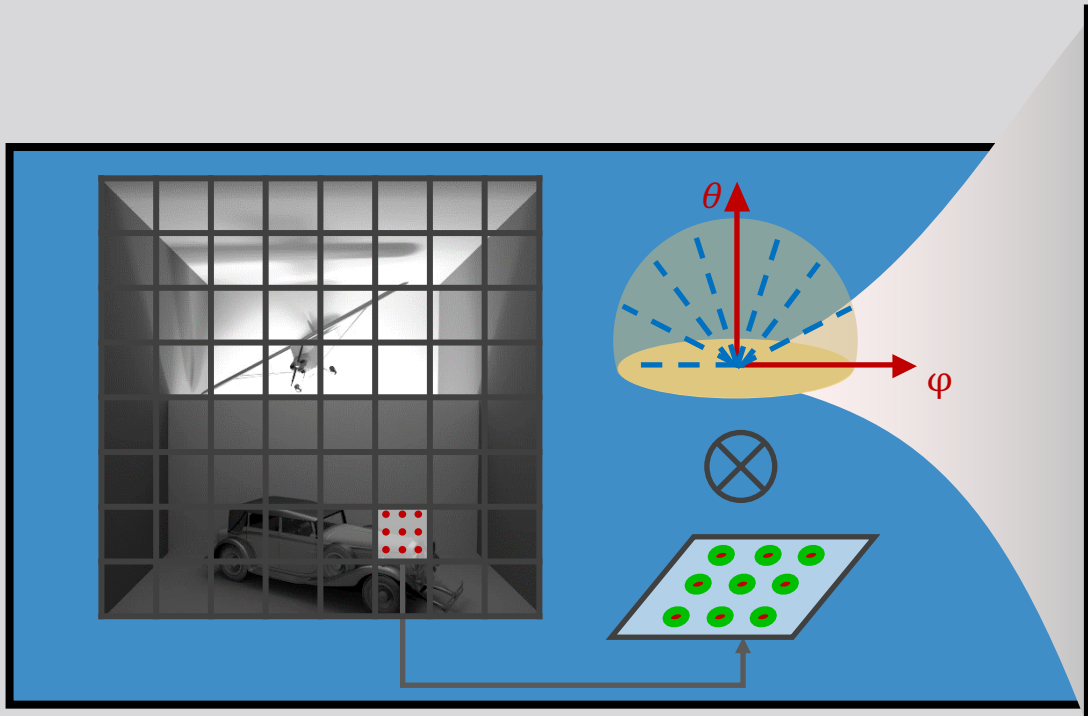



## Reconstruction:

- ✓ To guide path tracing
- ✓ To generate preview
- ✓ Others
- ❖ Extremely sparse samples
- ❖ Memory/computation overhead
- ❖ Hard to find ground-truth

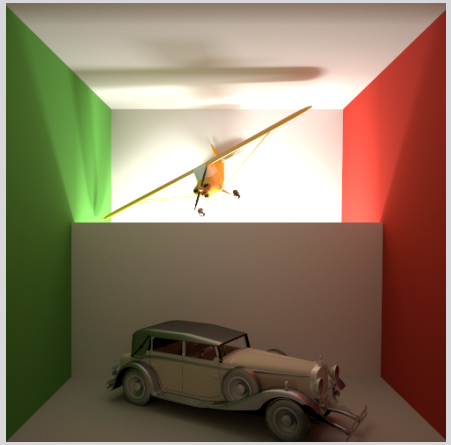


# Radiance Field Reconstruction using Deep Reinforcement Leaning



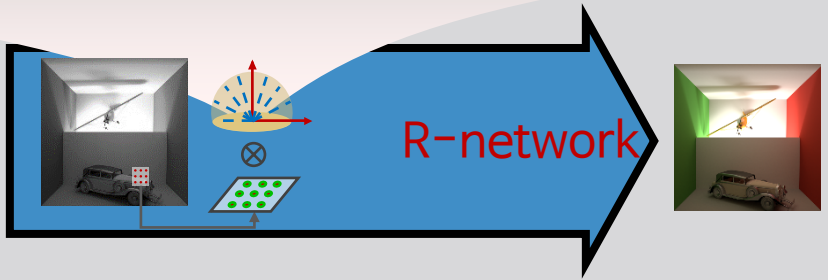

**Q-network:**
Adaptive sampling and refining the radiance field, trained by DRL

**R-network:**
Reconstruct 4D radiance field in both image and direction spaces

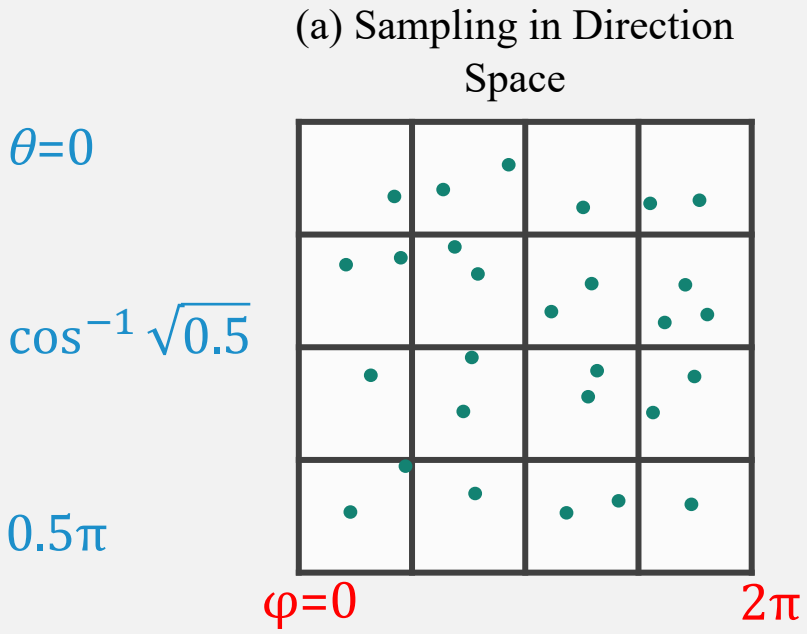


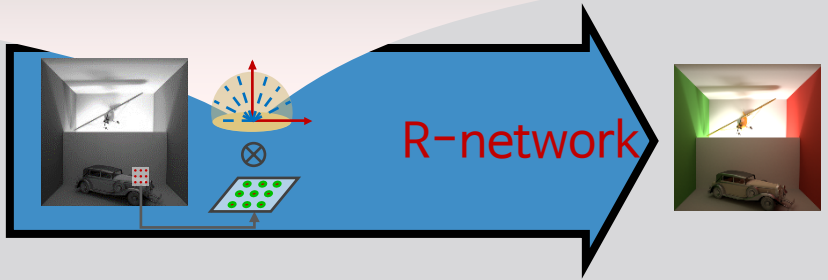
# Adaptive Sampling and Refining

Q-network:

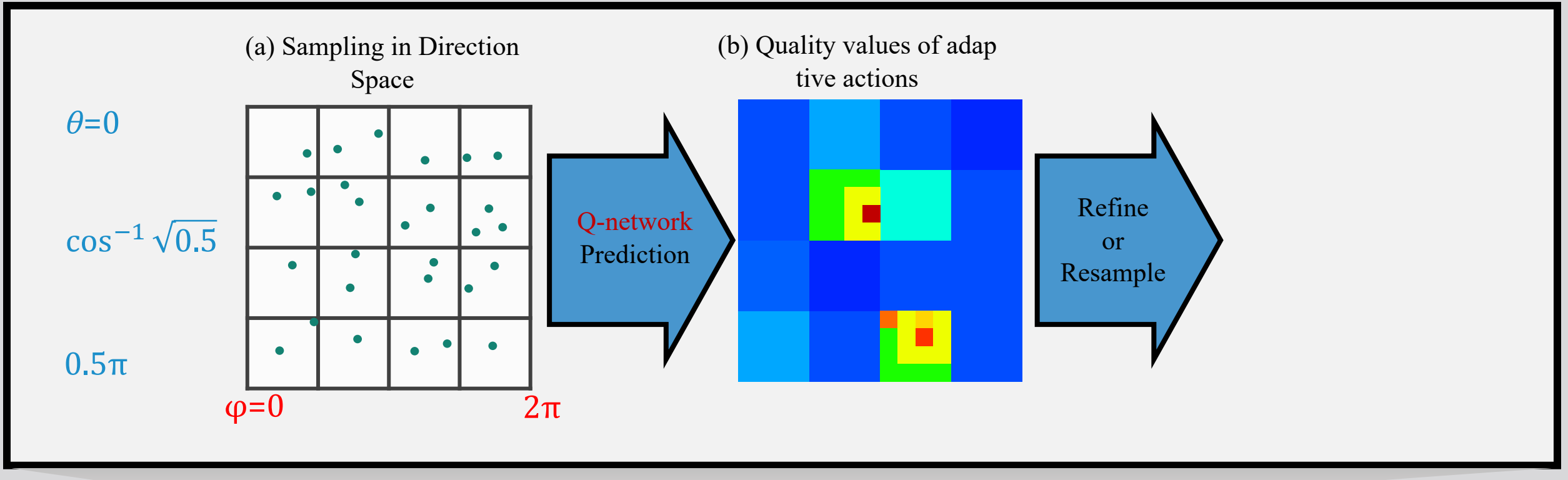


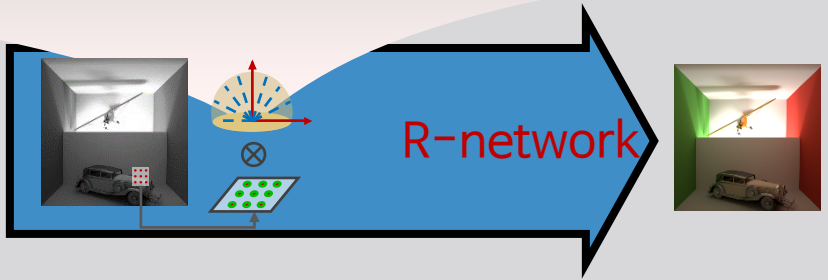
# Adaptive Sampling and Refining



# Adaptive Sampling and Refining



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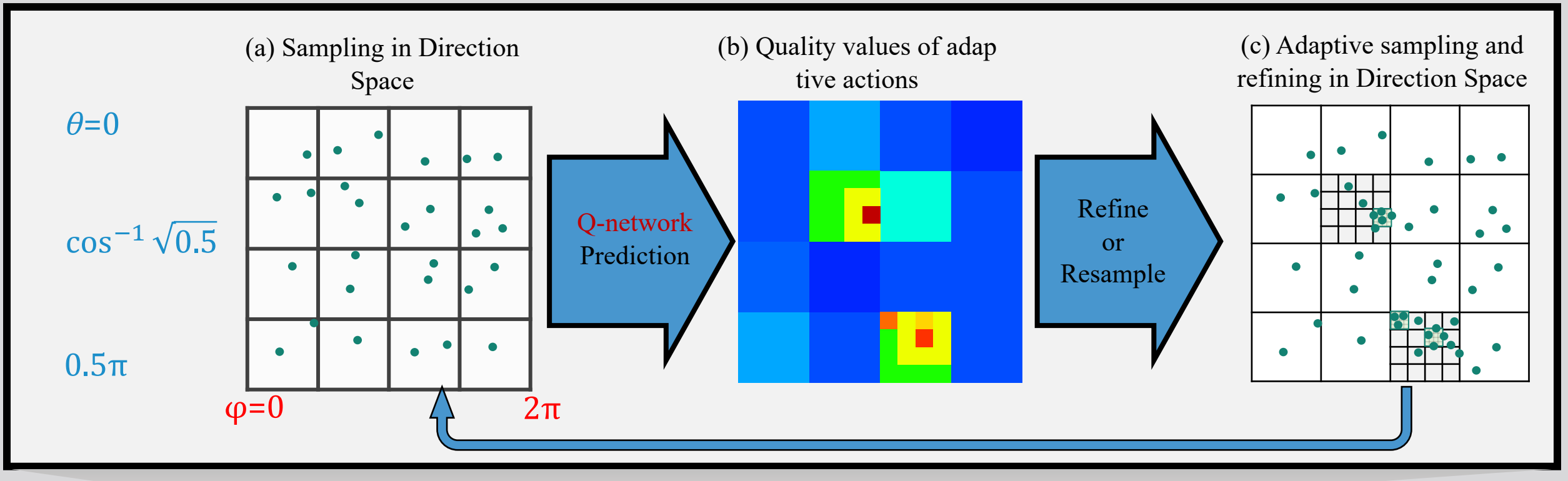
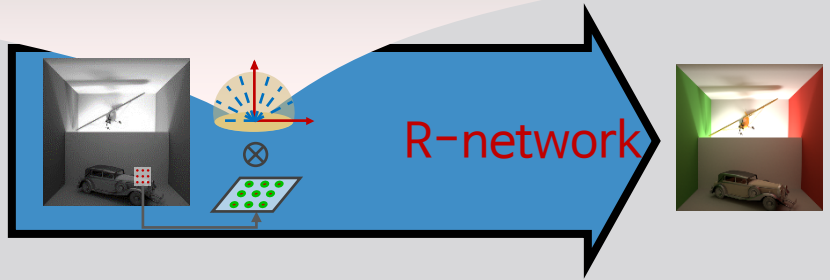


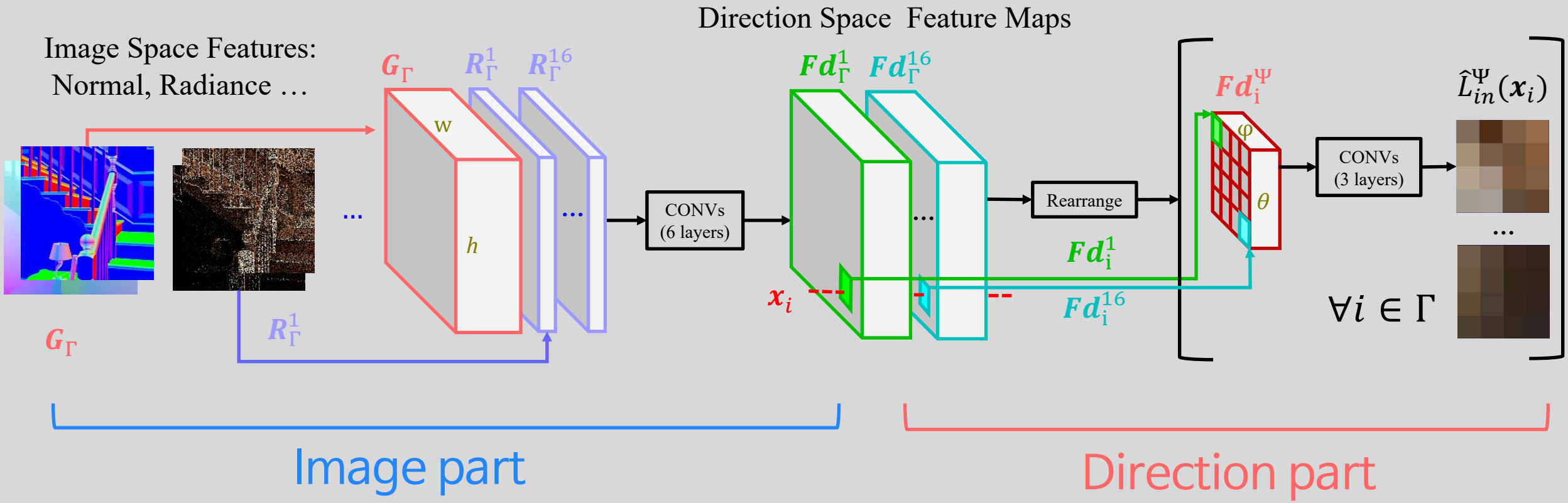



# R-network

- Explore 4D radiance field in:
  - Image-direction
  - Direction-image
  - Direction
  - Image

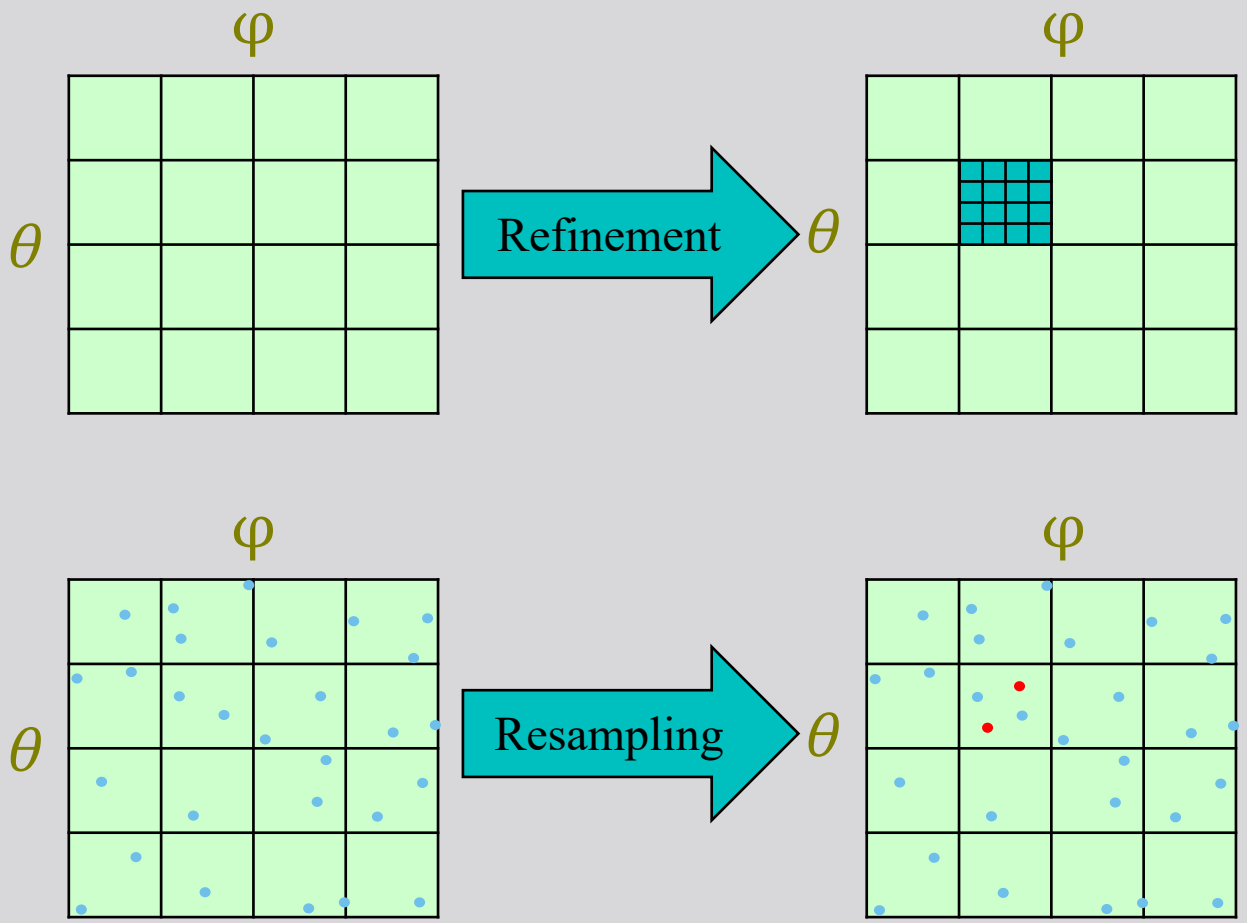
# R-network

- Image-direction network:

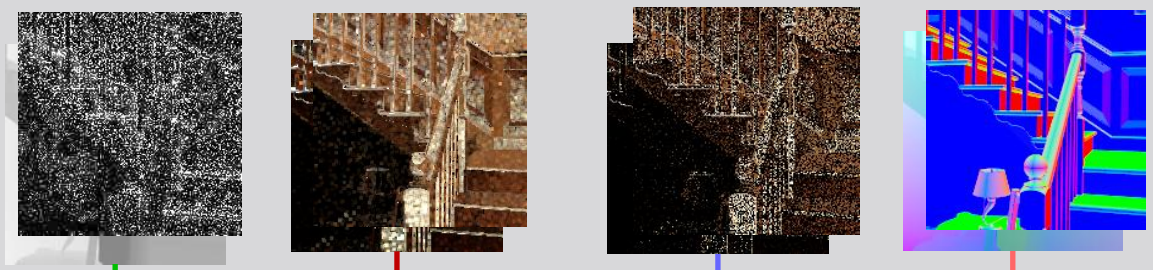


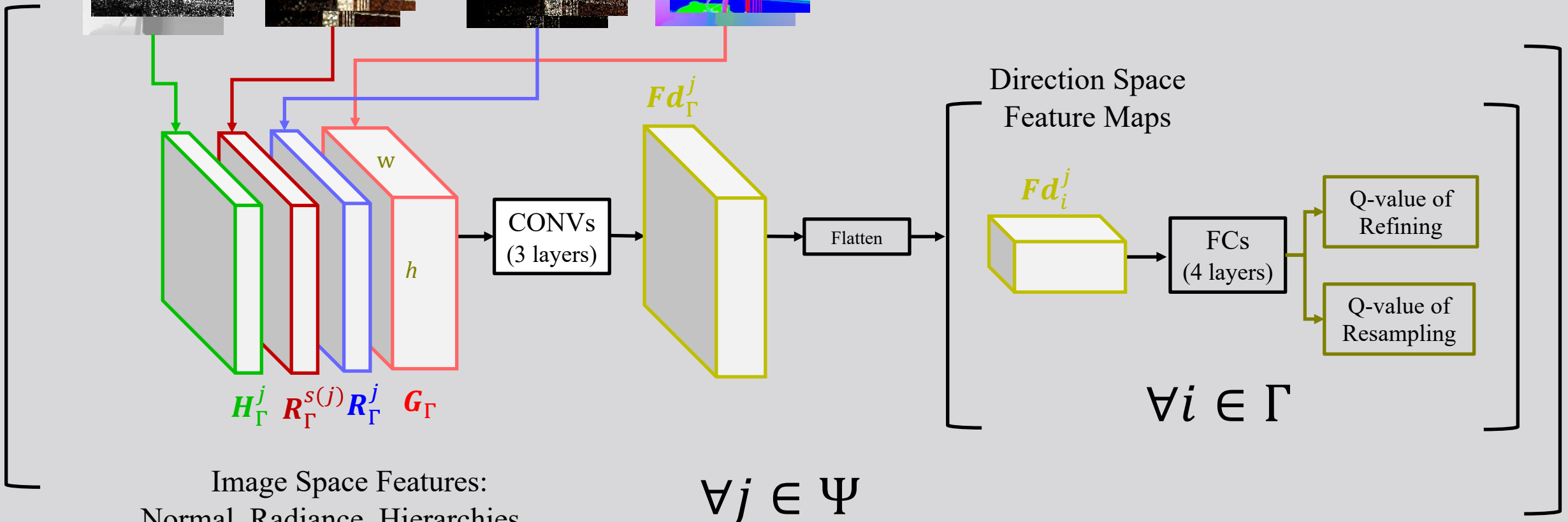
# Q-network

- Actions:
  - Refinement
  - Resampling
- Q-value(reward):
  - Decline of the Difference between GT and R-network output

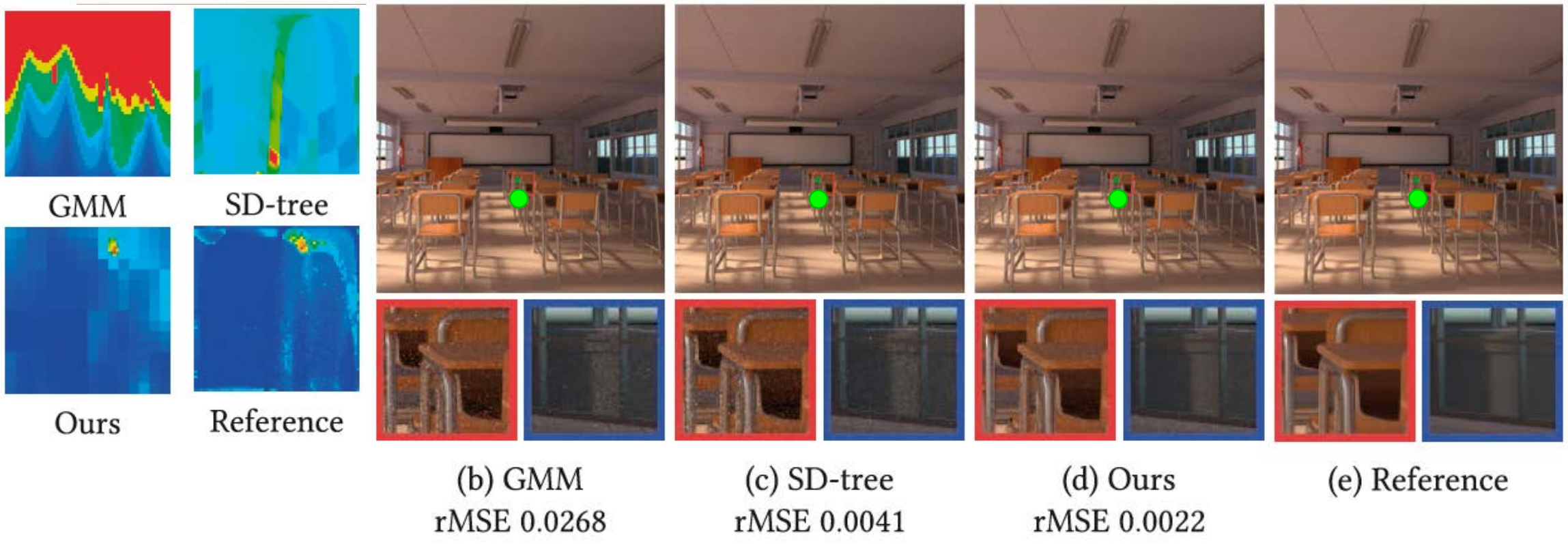


# Q-network




w
h
$H_\Gamma^j$ $R_\Gamma^{s(j)}$ $R_\Gamma^j$ $G_\Gamma$
CONVs
(3 layers)
$Fd_\Gamma^j$
Flatten
Direction Space
Feature Maps
$Fd_i^j$
FCs
(4 layers)
Q-value of
Refining
Q-value of
Resampling
$\forall i \in \Gamma$
Image Space Features:
Normal, Radiance, Hierarchies …
$\forall j \in \Psi$

# Results (path guiding)



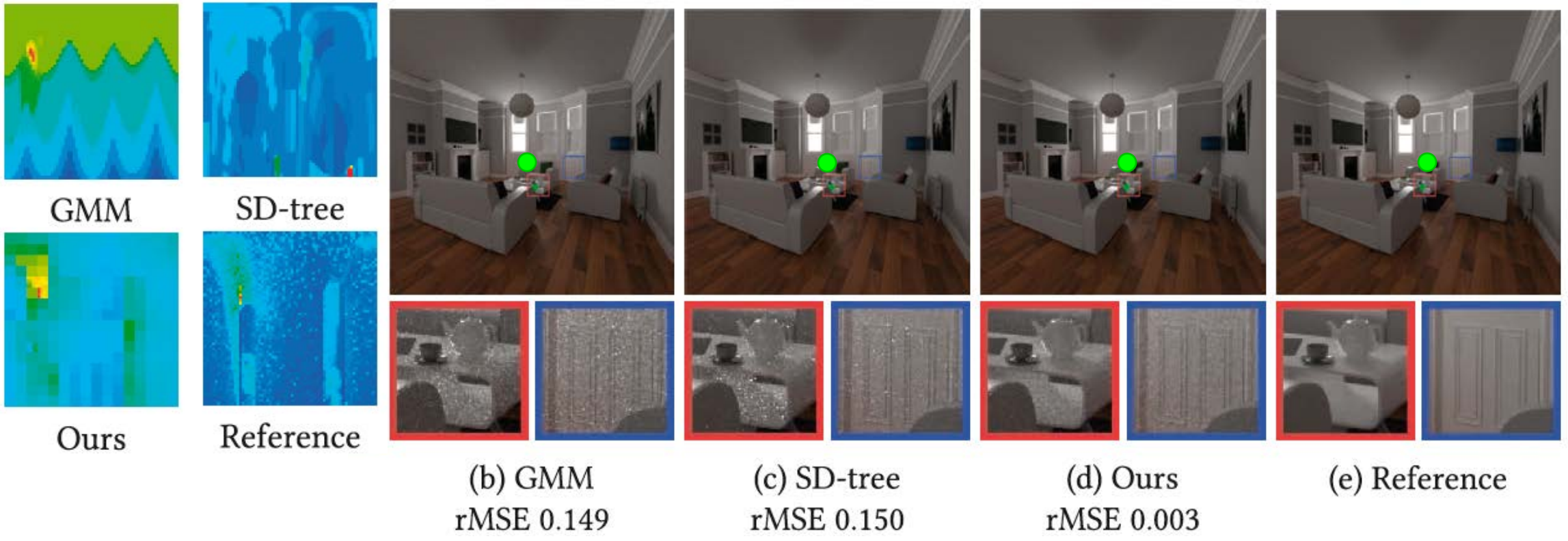

(b) GMM
rMSE 0.0268

(c) SD-tree
rMSE 0.0041

(d) Ours
rMSE 0.0022

(e) Reference

# Results (path guiding)



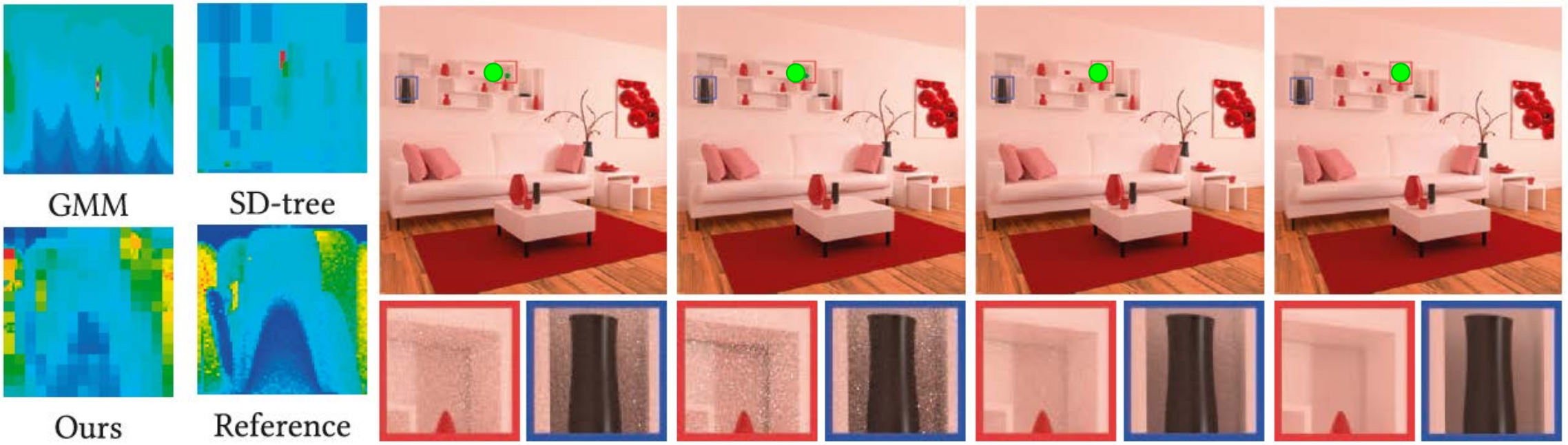

(b) GMM
rMSE 0.149

(c) SD-tree
rMSE 0.150

(d) Ours
rMSE 0.003

(e) Reference

# Results (path guiding)



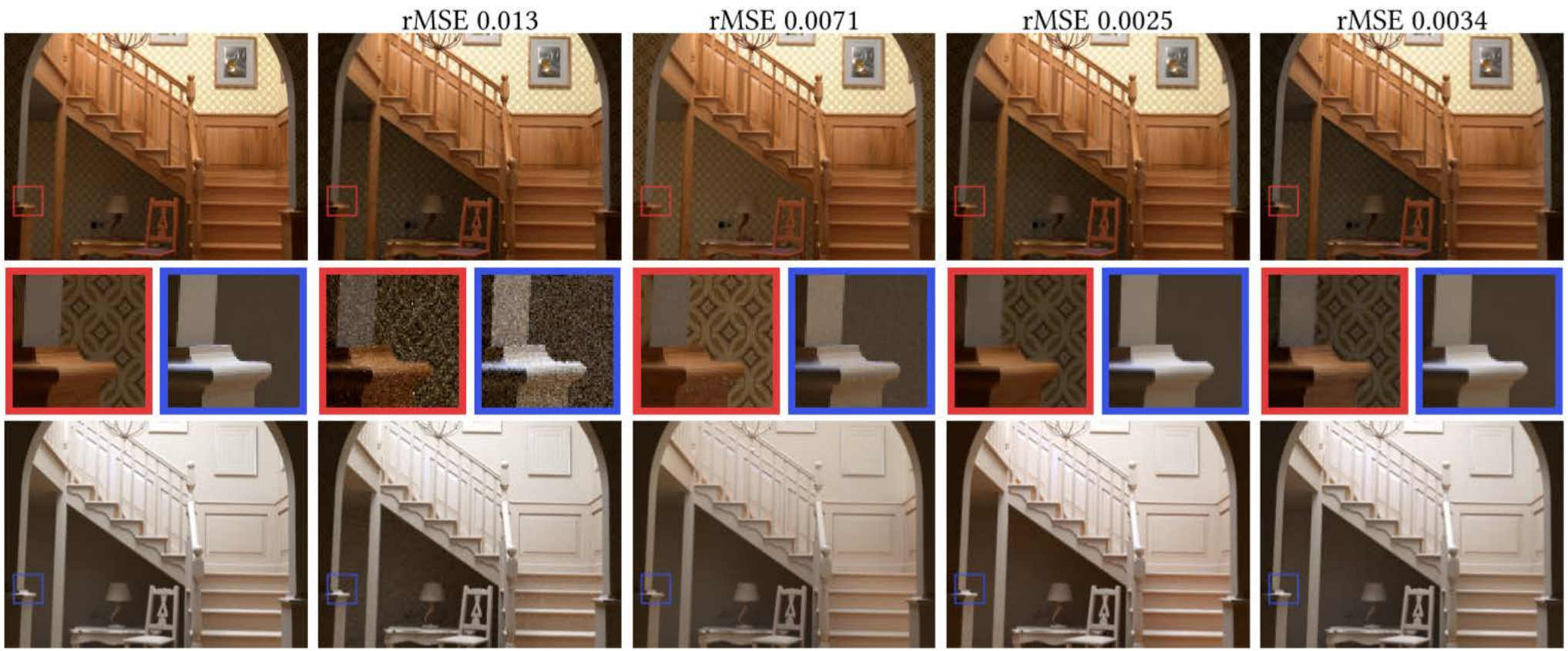

(b) GMM
rMSE 0.0.00072

(c) SD-tree
rMSE 0.0201

(d) Ours
rMSE 0.00035

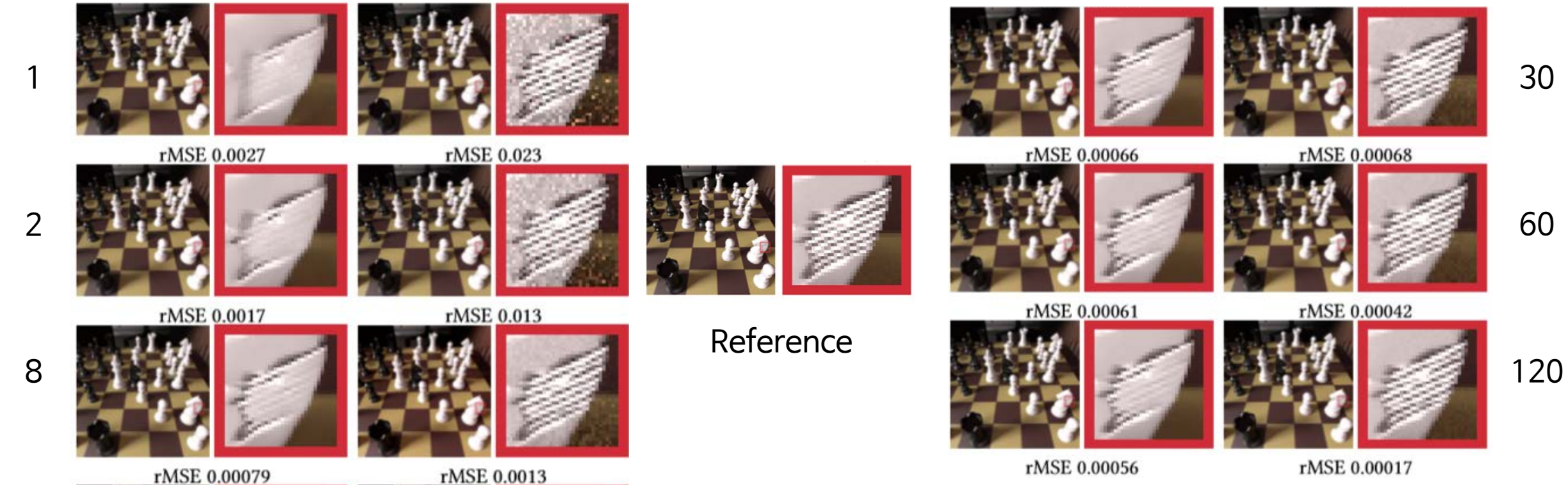
(e) Reference

# Results (direct filtering)




(a) Reference (b) PT (c) REC (d) KPCN (e) Ours

# Results (Filtering v.s. Path Guiding)



# THANK YOU