Robotics and
Visual Intelligence Lab

PixelSynth: Generating a 3D-Consistent Experience from a Single Image

ICCV 2021

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University of Michigan

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Lab Seminar

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Introduction

Network

Experiments

Conclusion

Introduction

View Synthesis?

Introduction

View Synthesis?

Introduction

View Synthesis?

Introduction

Single Image View Synthesis

Introduction

Single Image View Synthesis

Introduction

Single Image View Synthesis

Translation: Step Forward
Rotation: Turn left

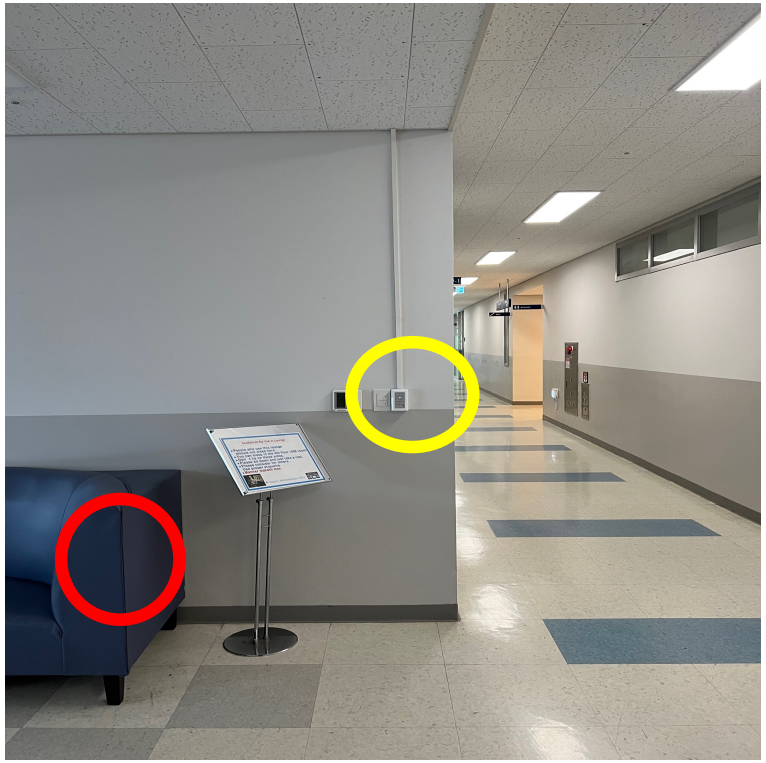
Introduction

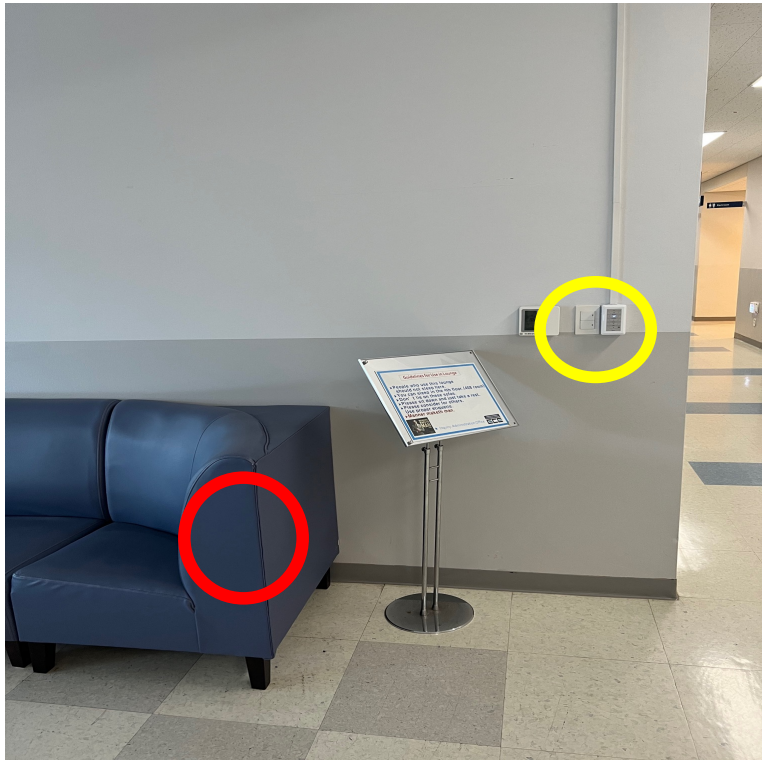
Single Image View Synthesis

Translation: Step Forward
Rotation: Turn left

Introduction

Challenges of Single Image View Synthesis





Challenge 1: Need to know depth

Introduction

Challenges of Single Image View Synthesis

Challenge 2: Inpainting missing regions

Introduction

Challenges of Single Image View Synthesis

Challenge 3: Outpainting missing regions consistently

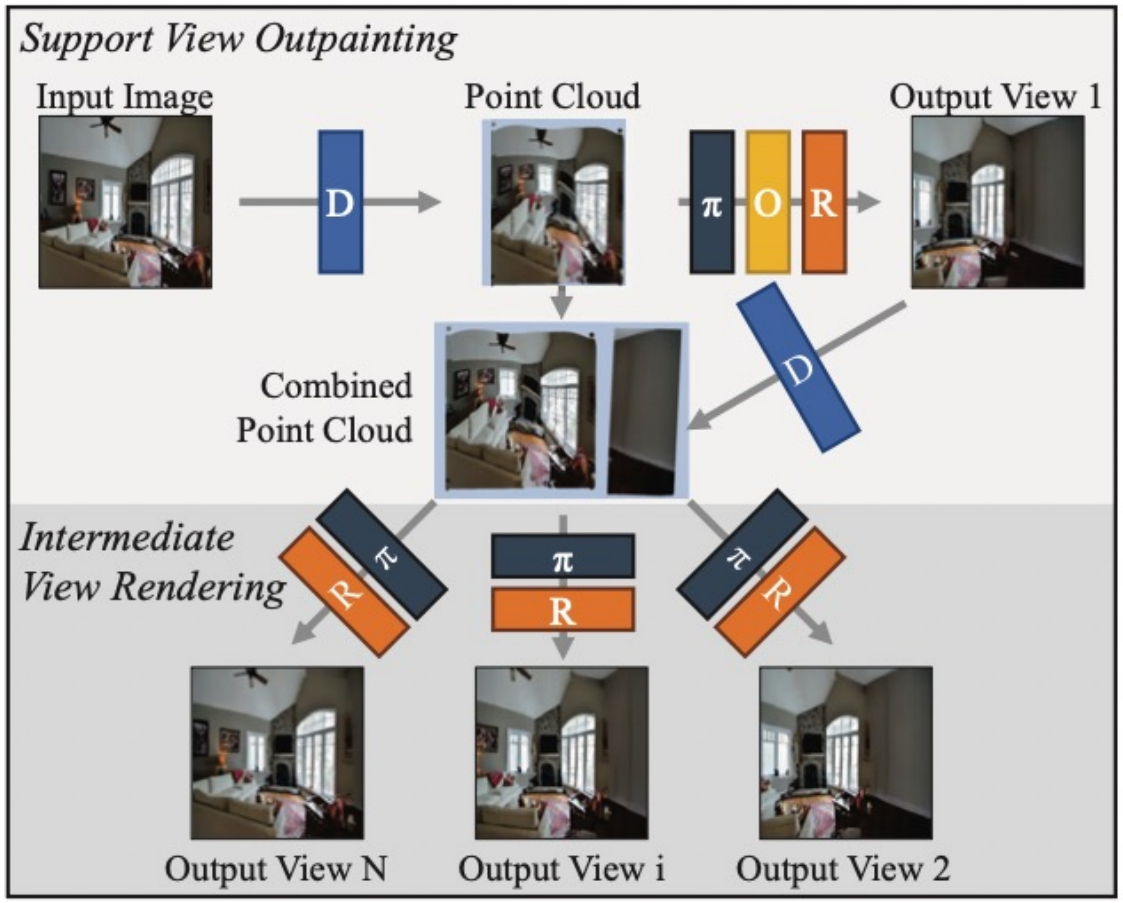
Introduction

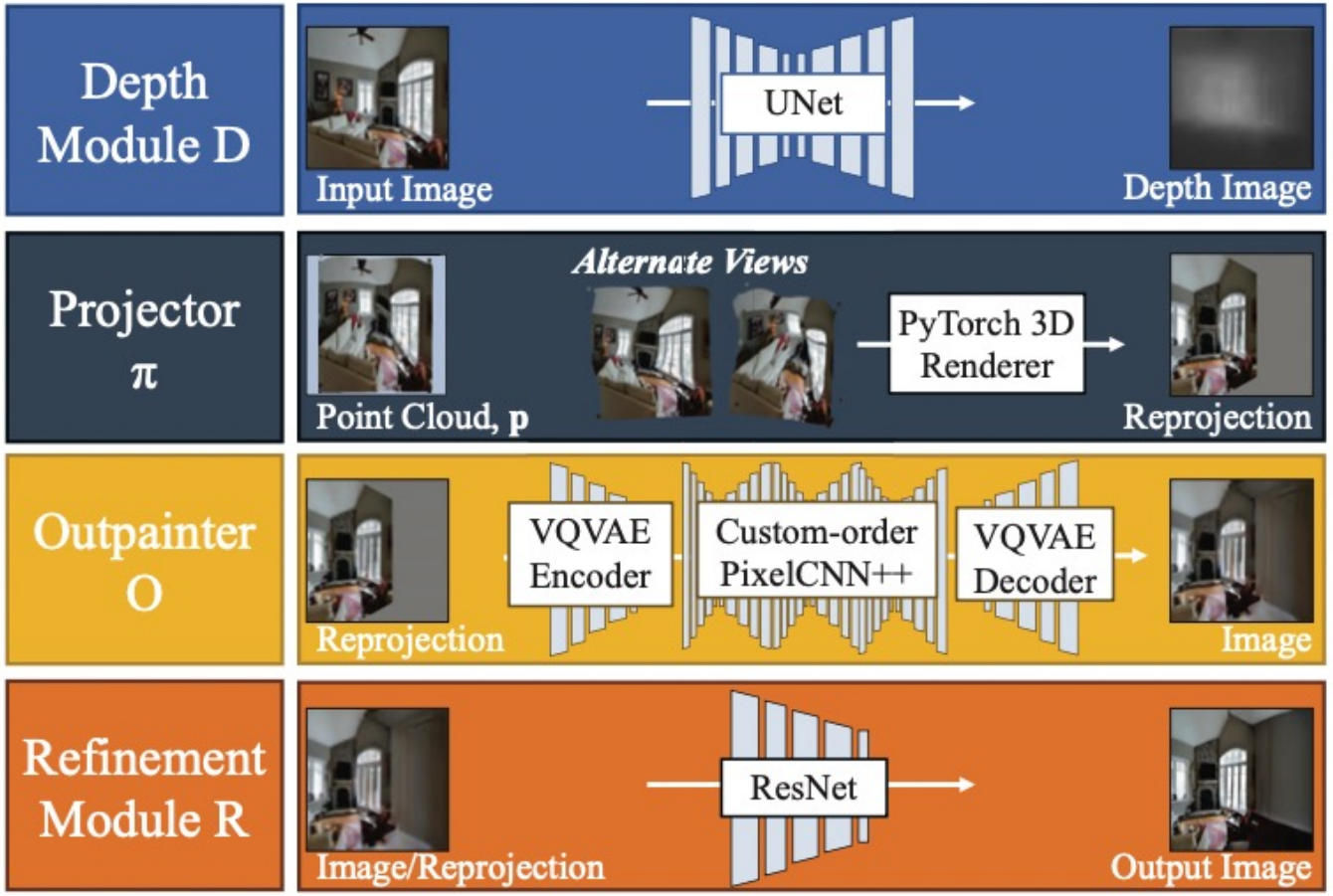
Network

Experiments

Conclusion

Network


Support View Outpainting
Input Image
D
Point Cloud
π
O
R
Output View 1
Combined
Point Cloud
D
Intermediate
View Rendering
R
π
π
R
π
R
Output View N
Output View i
Output View 2


Depth
Module D
Input Image
UNet
Depth Image
Projector
π
Alternate Views
Point Cloud, p
PyTorch 3D
Renderer
Reprojection
Outpainter
O
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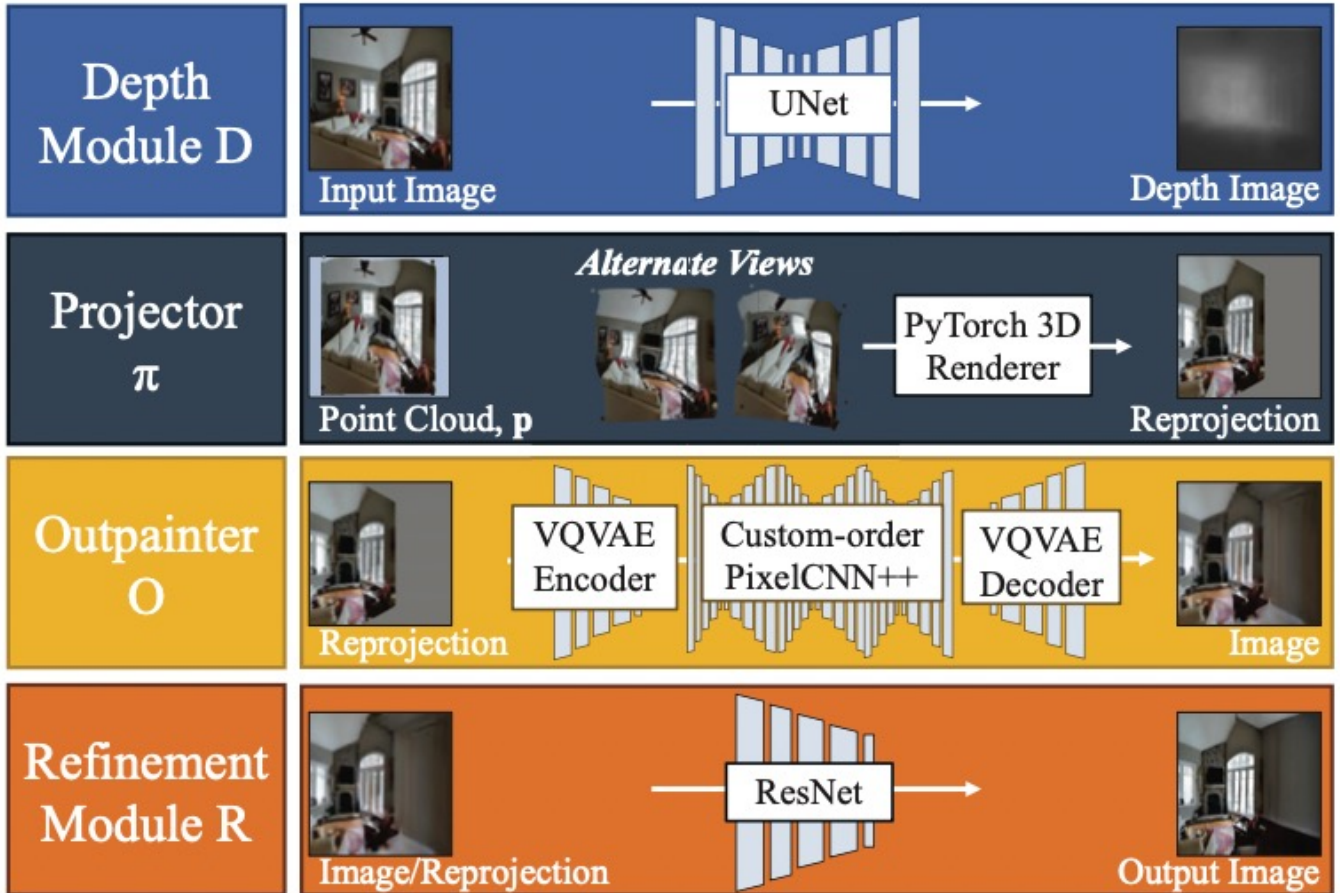
VQVAE
Encoder
Custom-order
PixelCNN++
VQVAE
Decoder
Image
Refinement
Module R
Image/Reprojection
ResNet
Output Image

Network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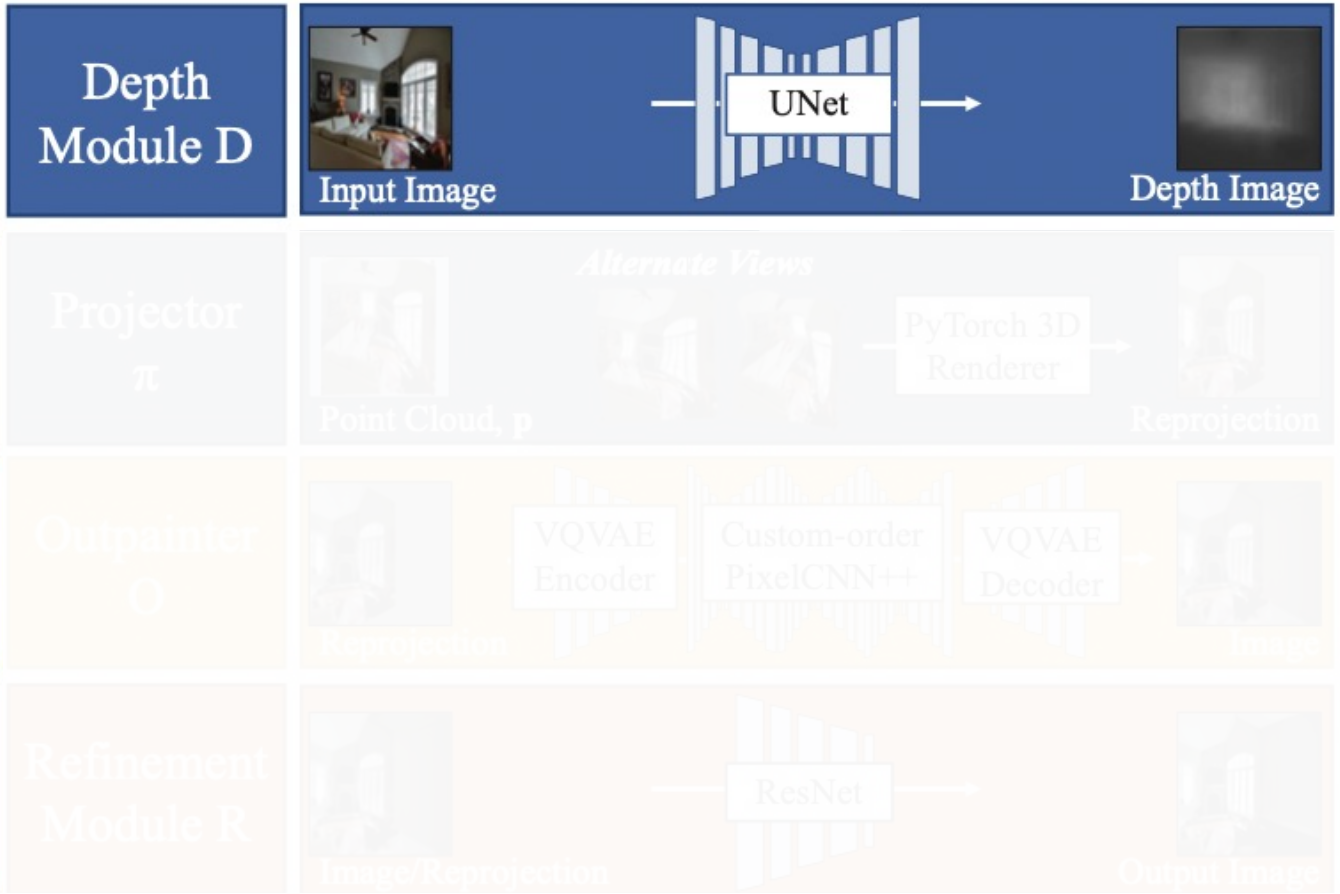


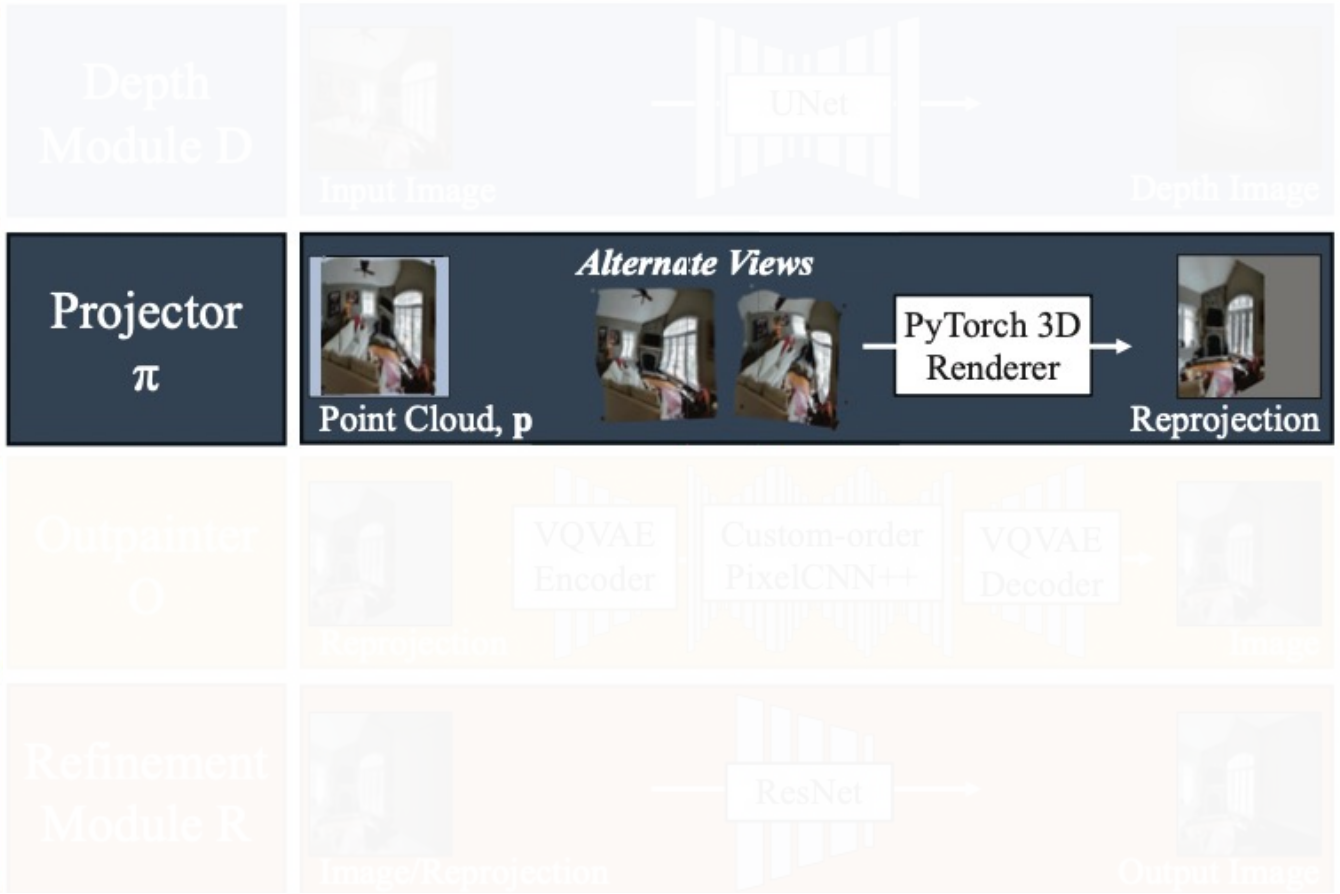
$$C = D(I)$$

Point Cloud

Depth Module

Image

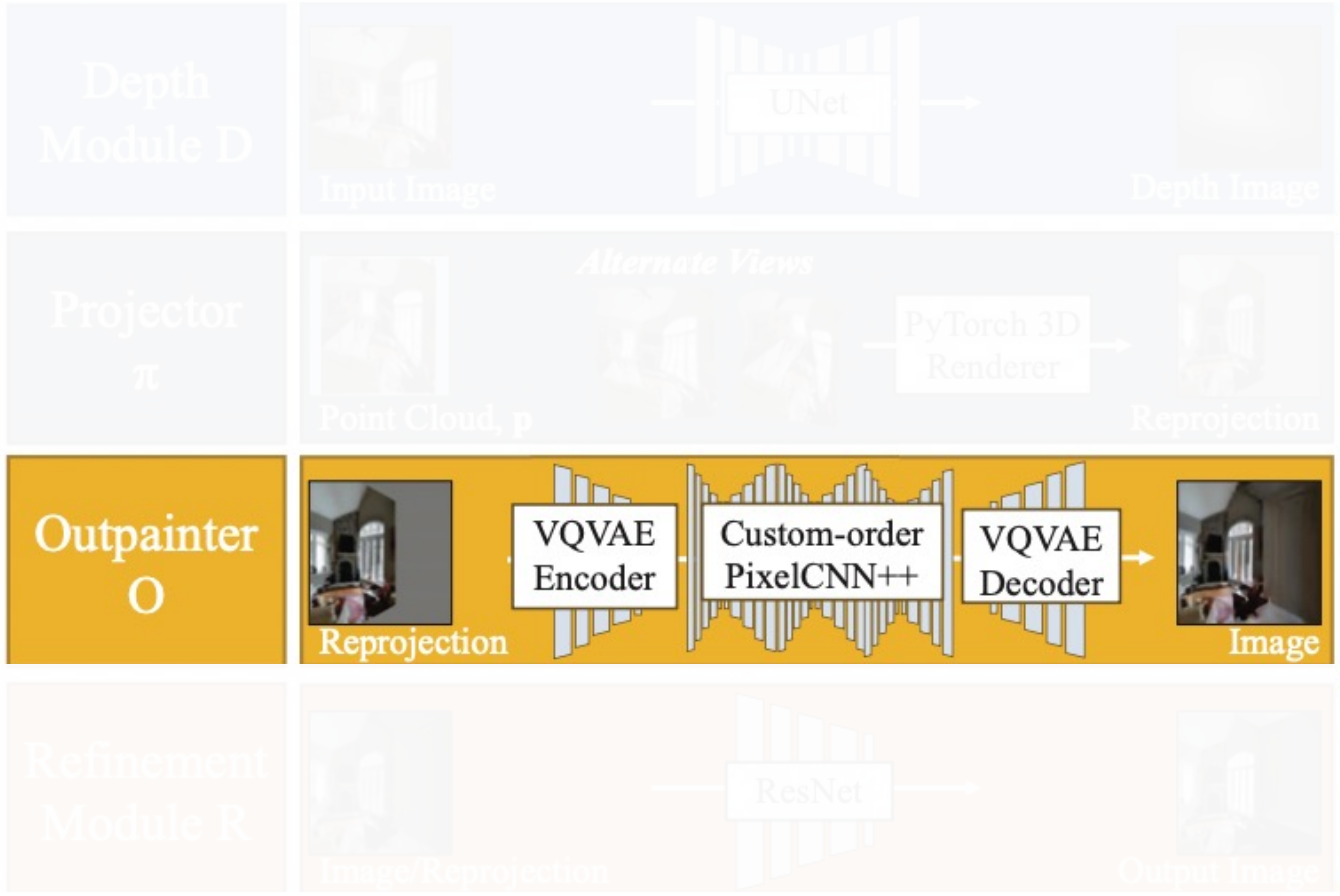
Network



$$I = \pi(C, \mathbf{p})$$

Image — Projector — Point Cloud — Target pose

Network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Image/Reprojection
ResNet
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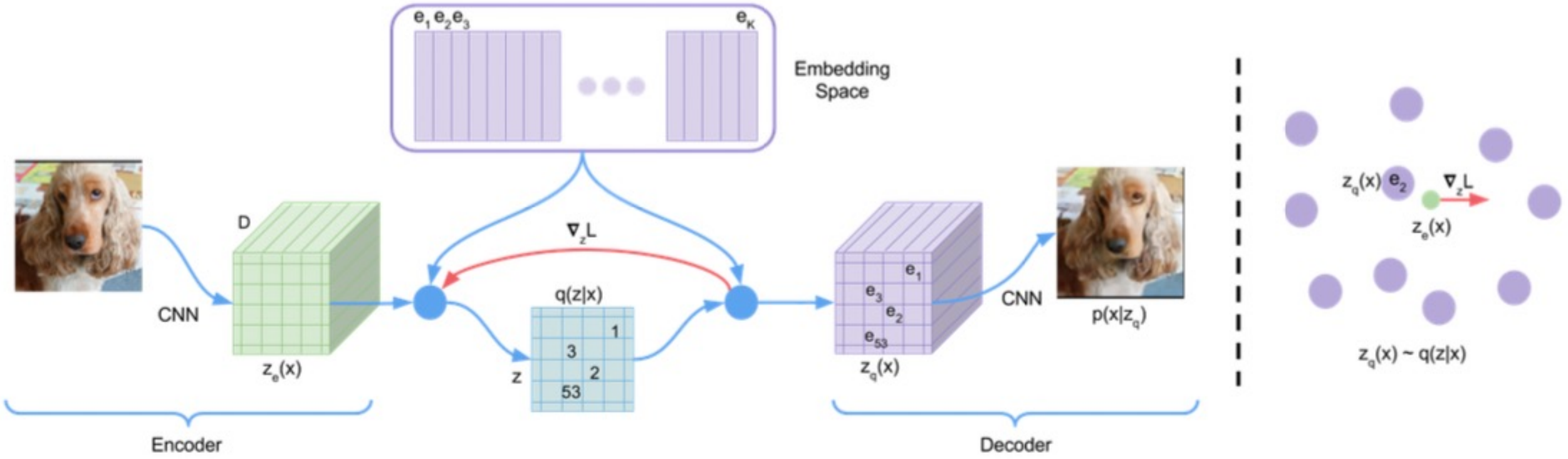
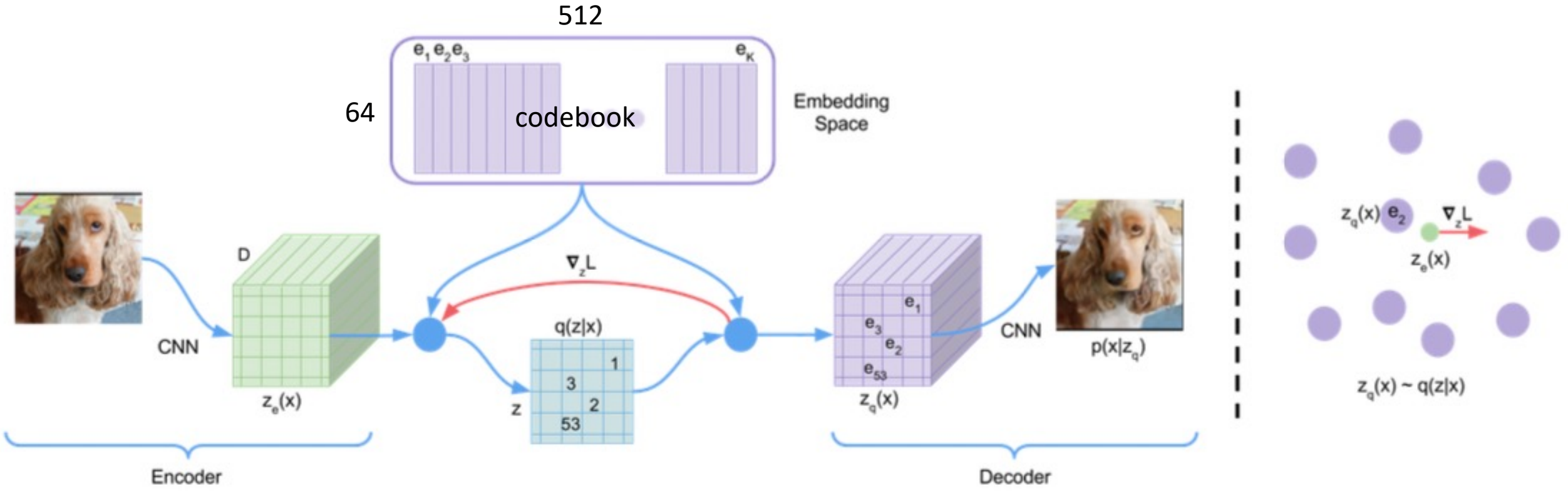
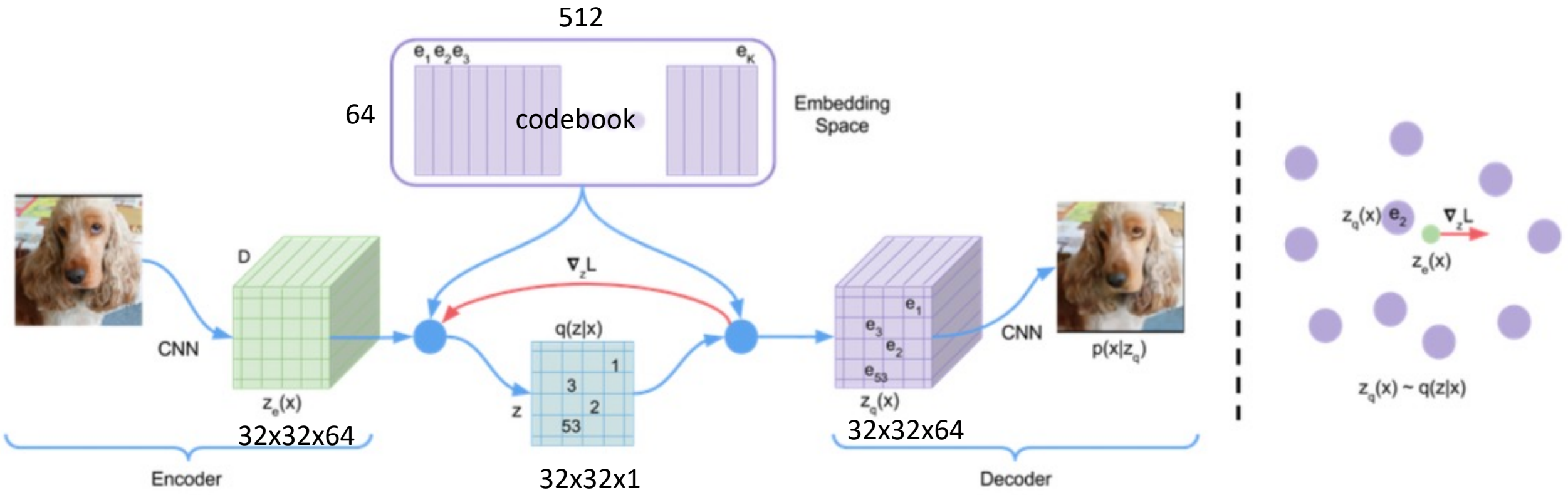
Network-VQVAE



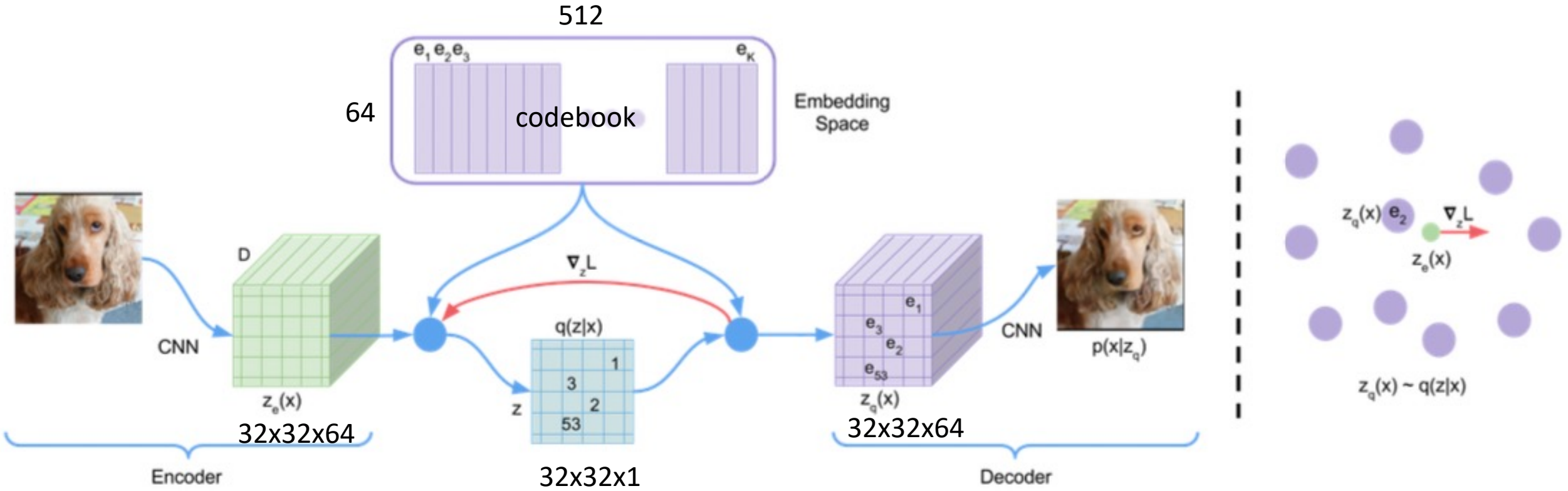
Network-VQVAE



Network-VQVAE



Network-VQVAE

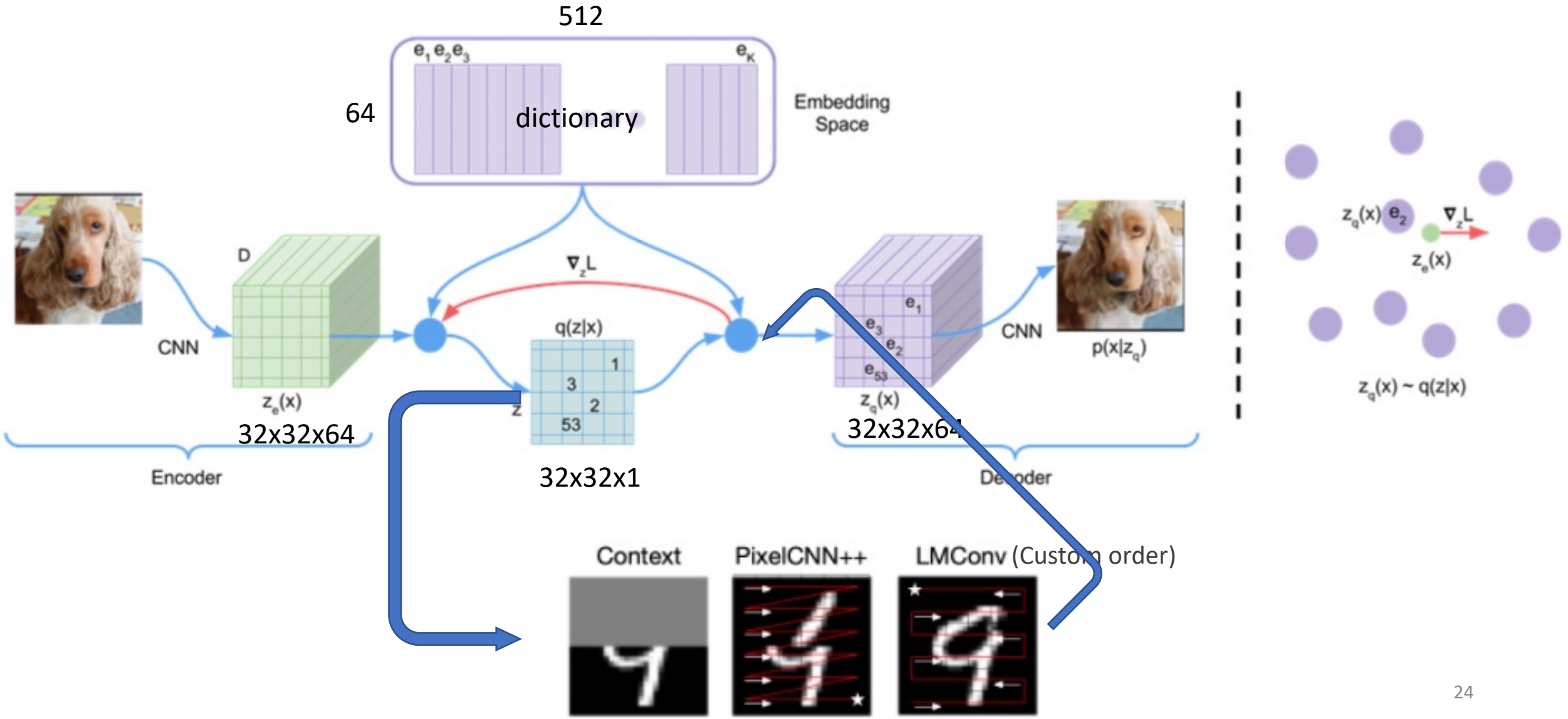


$$L = \log p(x|z_q(x)) + \|\text{sg}[z_e(x)] - e\|_2^2 + \beta\|z_e(x) - \text{sg}[e]\|_2^2,$$

$$= ||\mathbf{x} - D(\mathbf{e})||_2^2 + ||sg[E(\mathbf{x})] - \mathbf{e}||_2^2 + \beta||sg[\mathbf{e}] - E(\mathbf{x})||_2^2$$

reconstruction codebook commitment

Network-Custom order pixelcnn++



Network

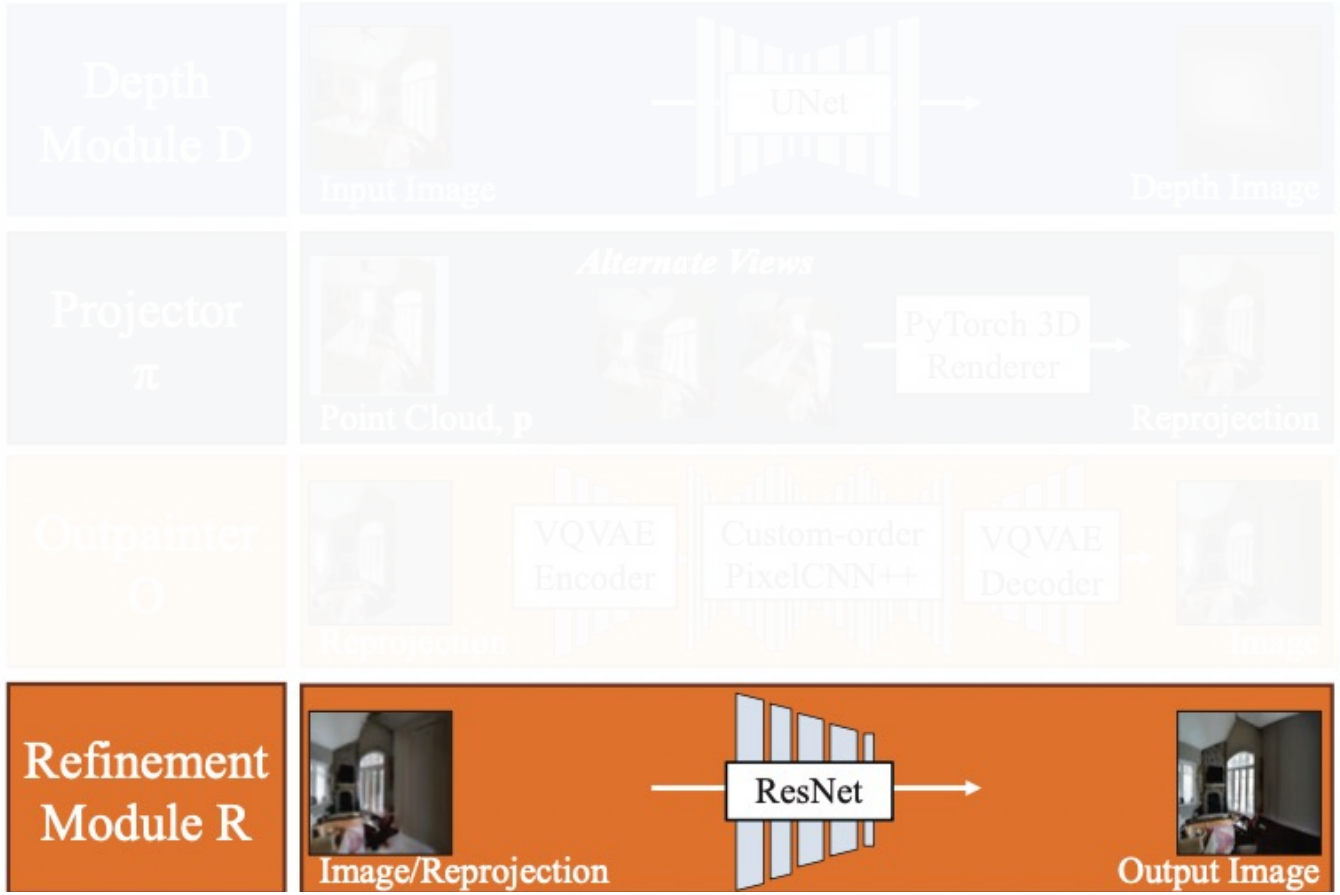

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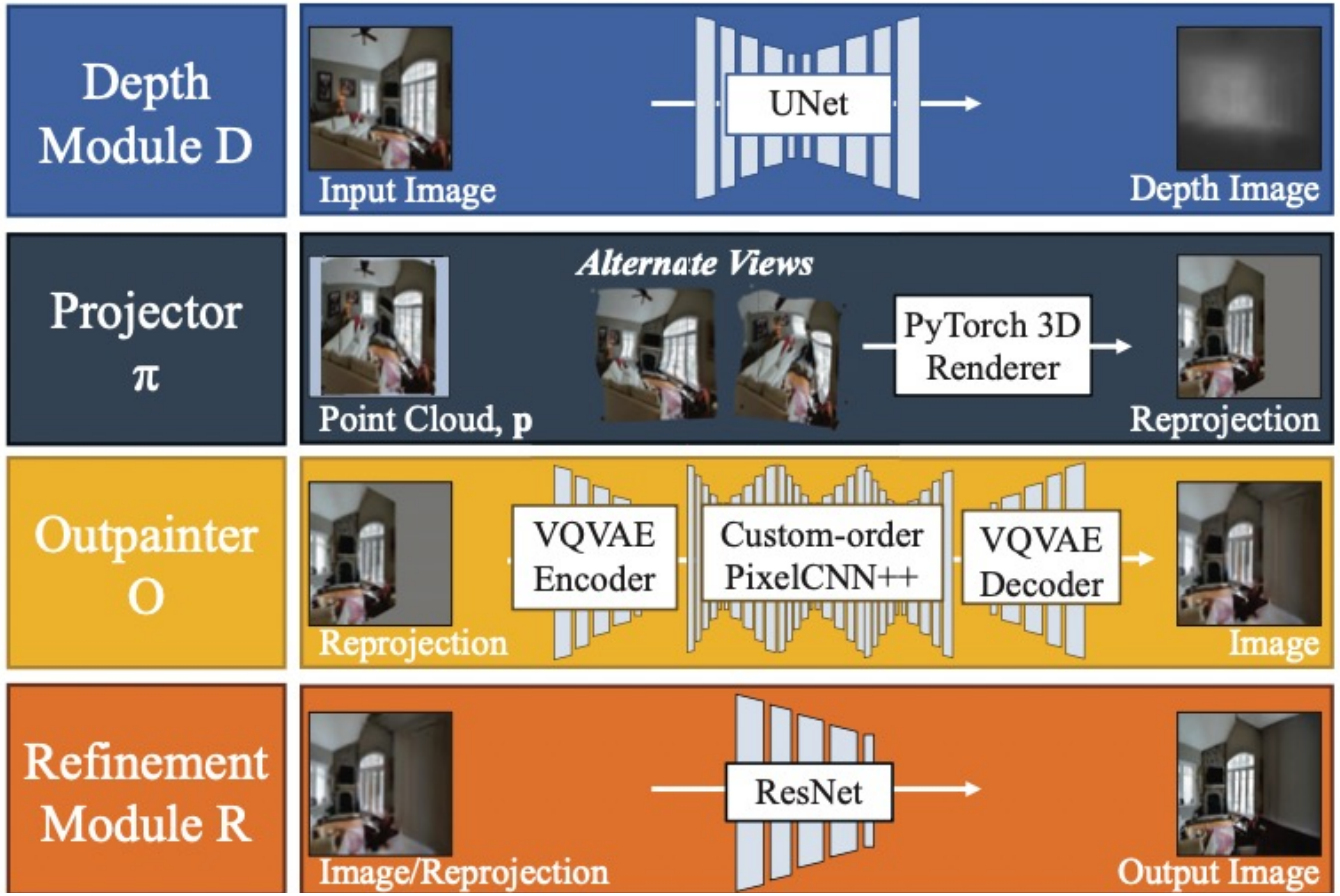
Image
Refinement Module R
Image/Reprojection
ResNet
Output Image

Network-Training



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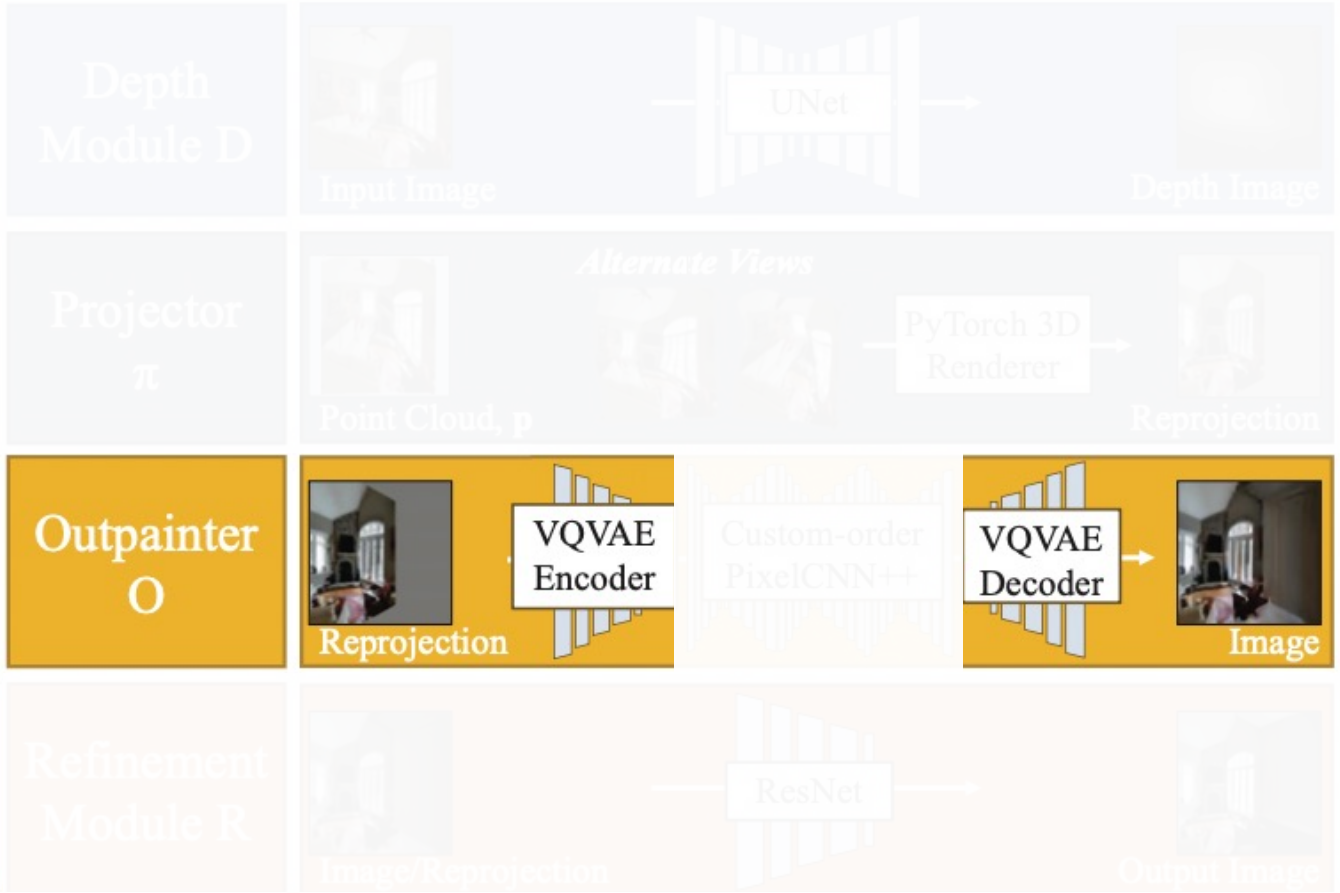
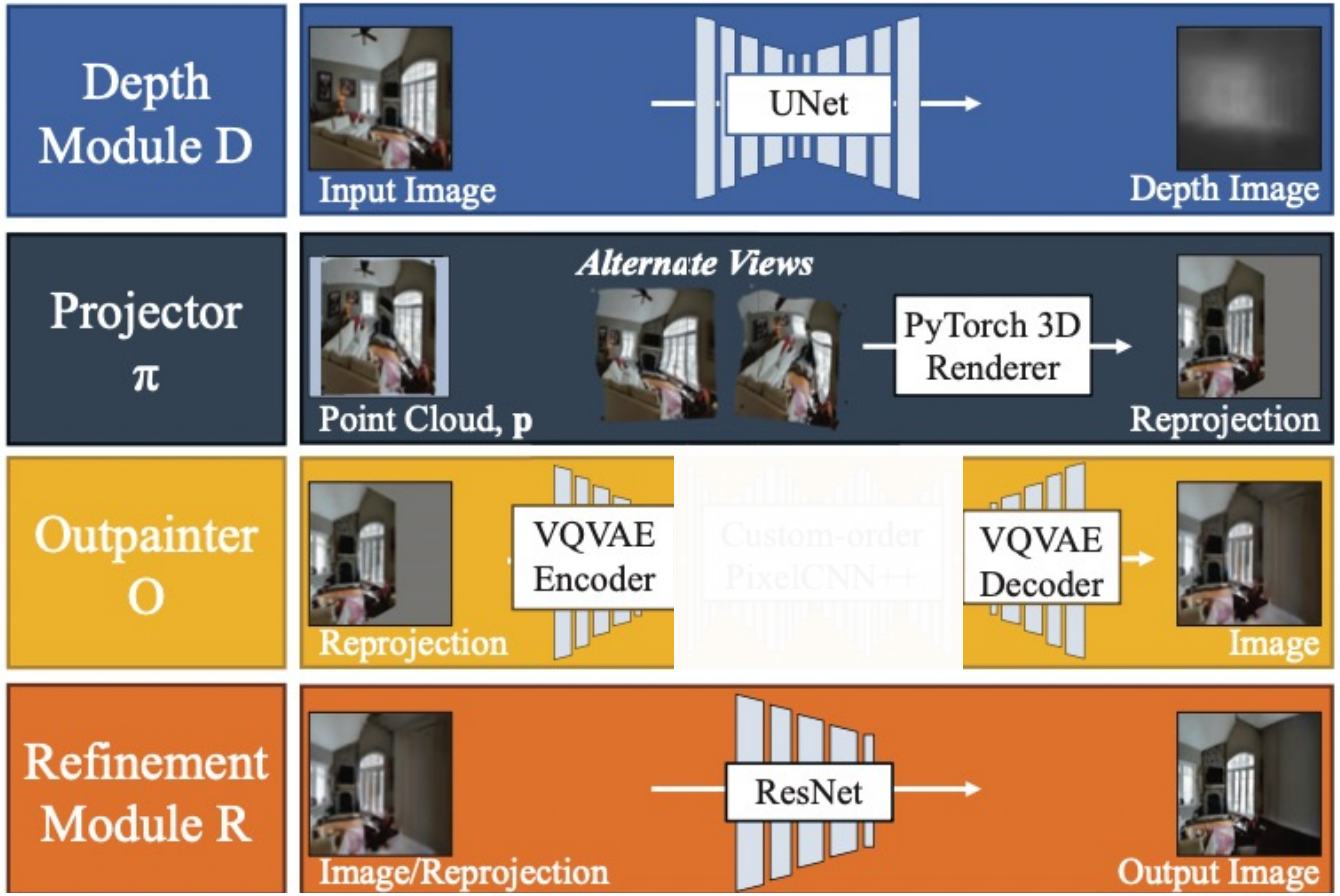
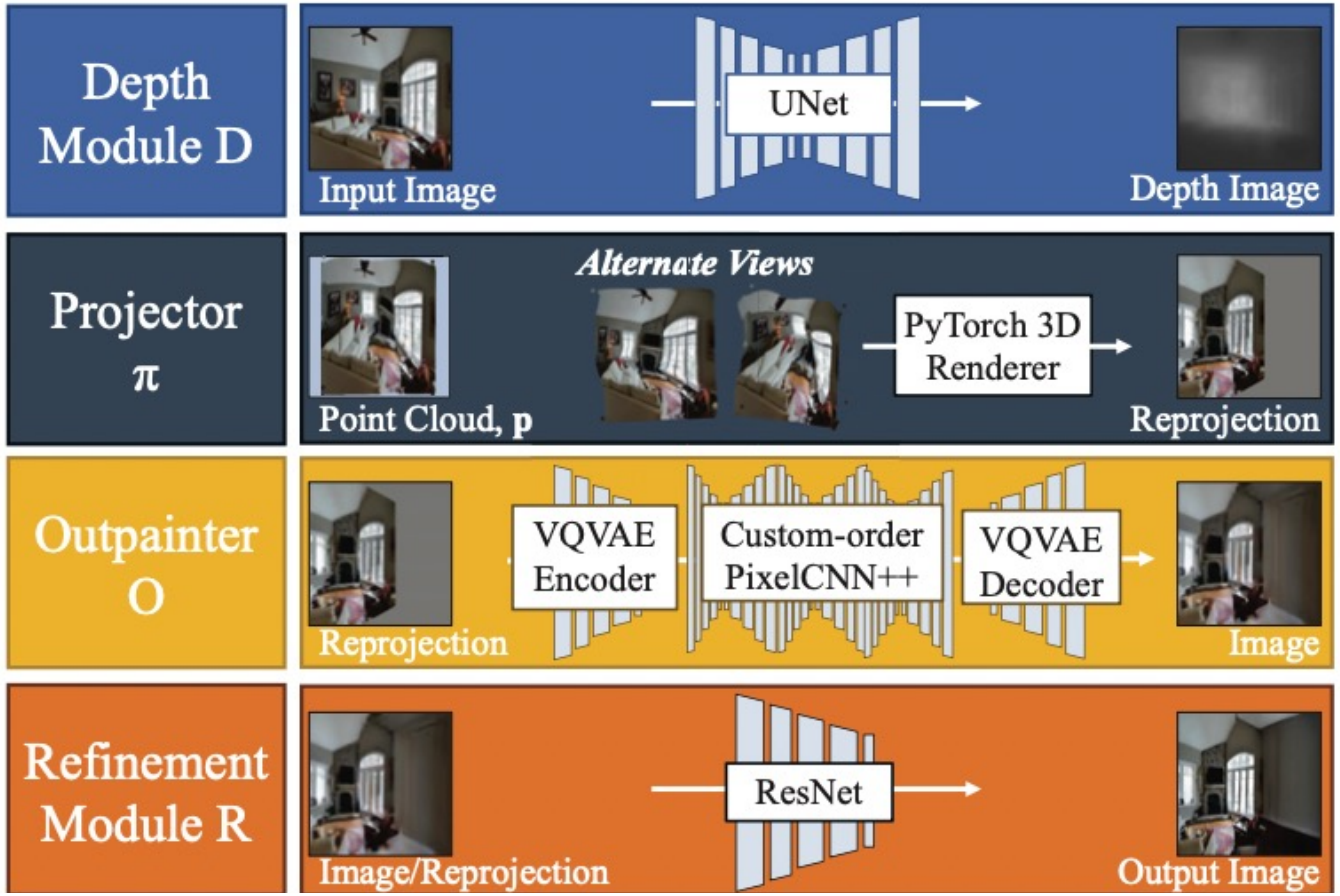


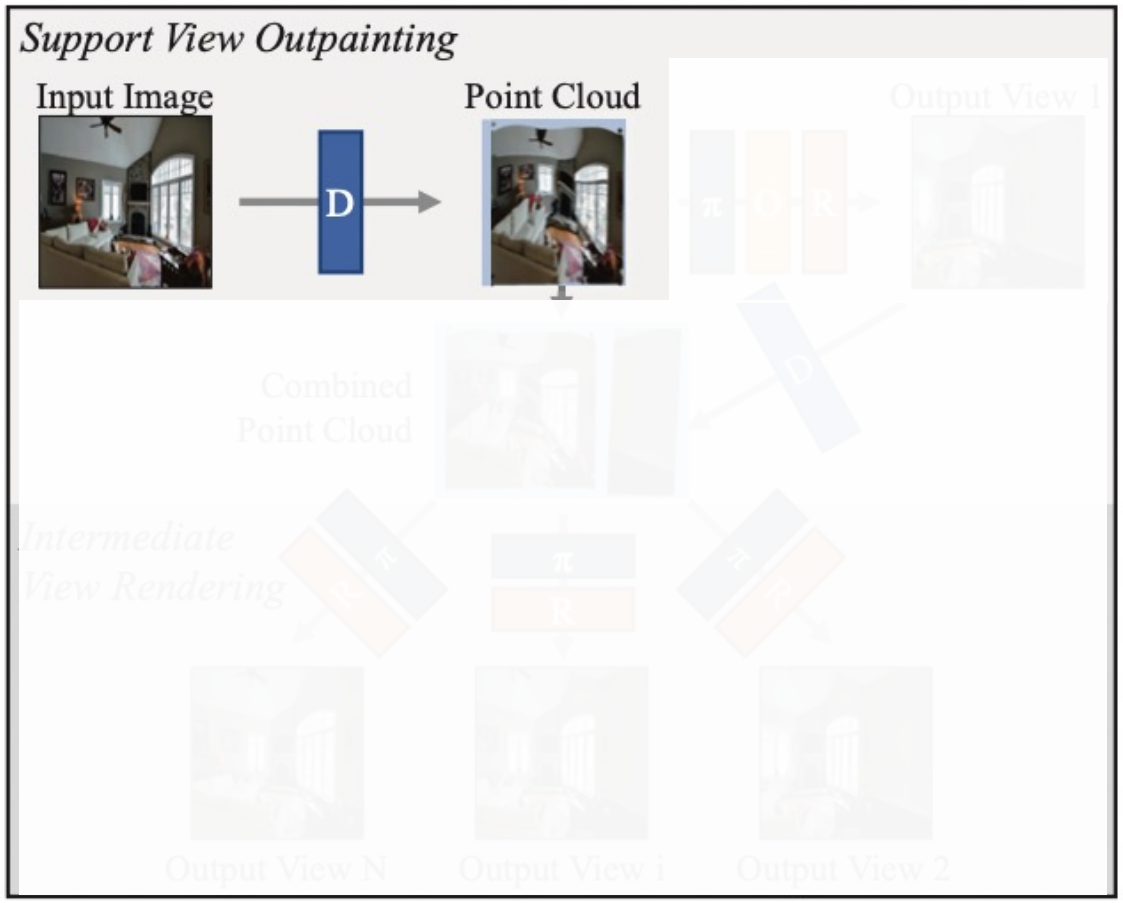
Network-Training



Network-Training



Network-Inference



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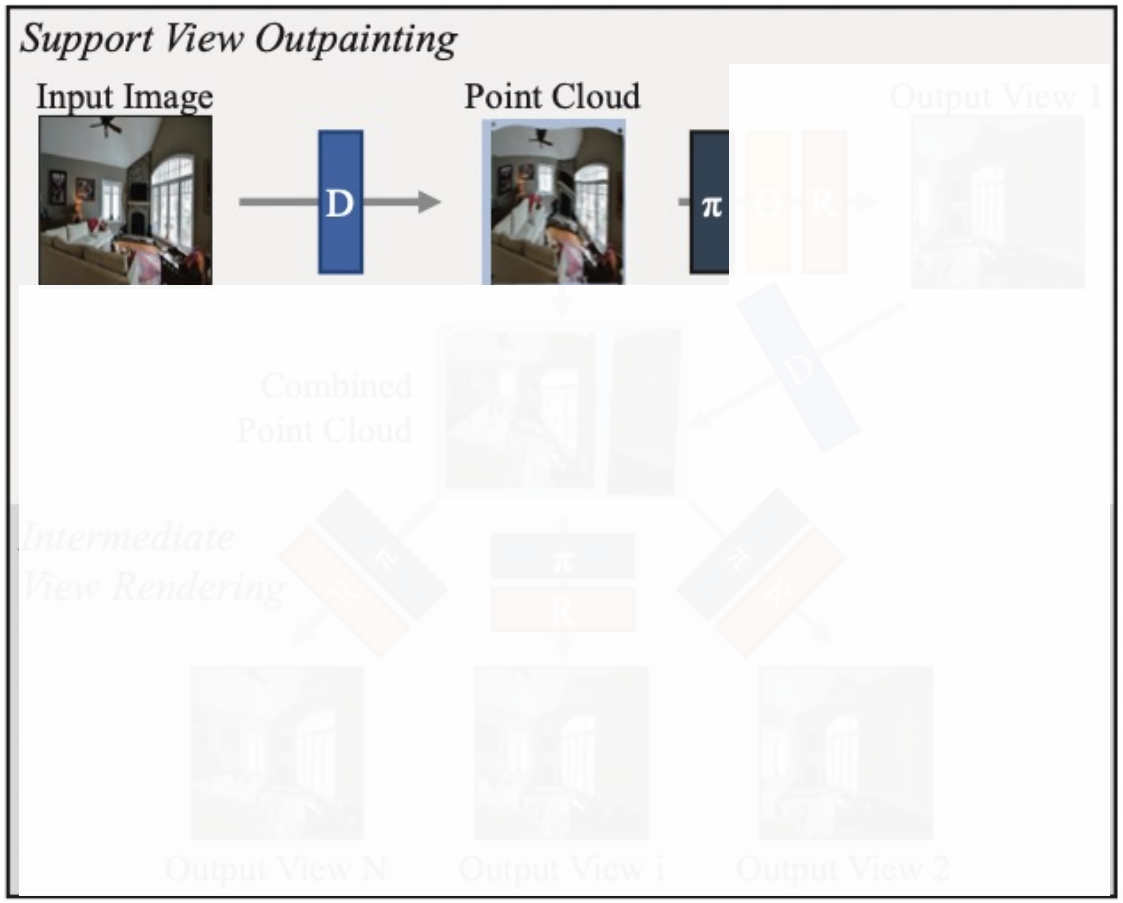
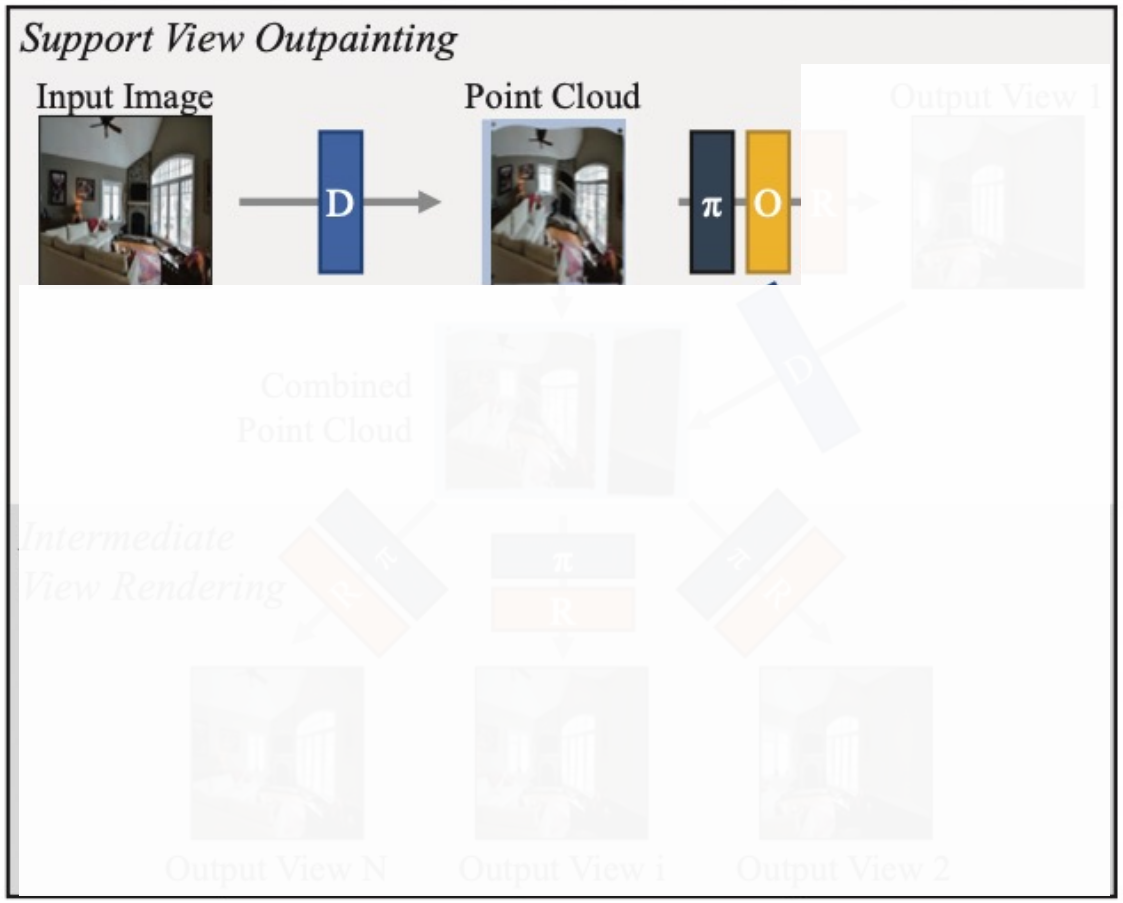
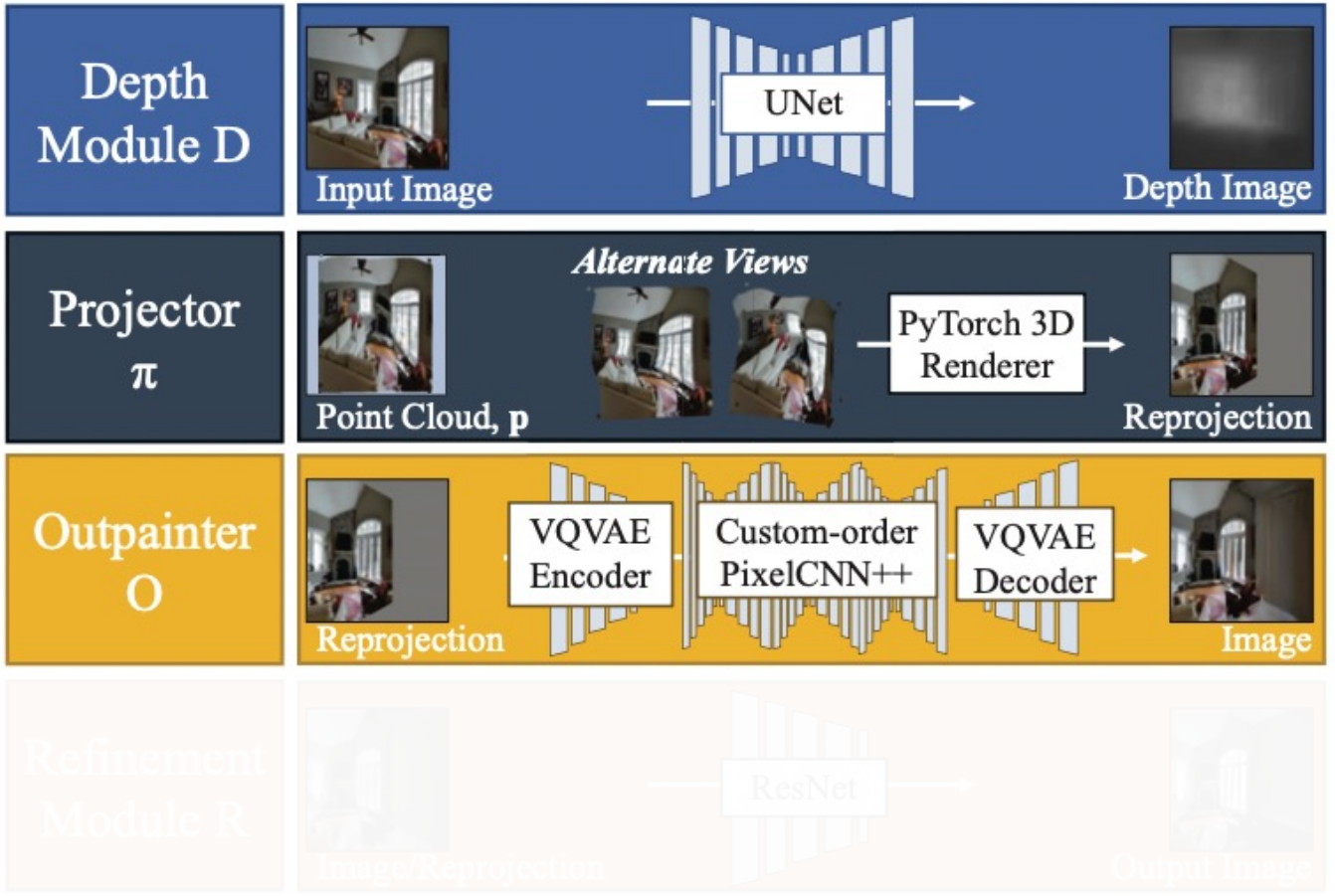


Network-Inference





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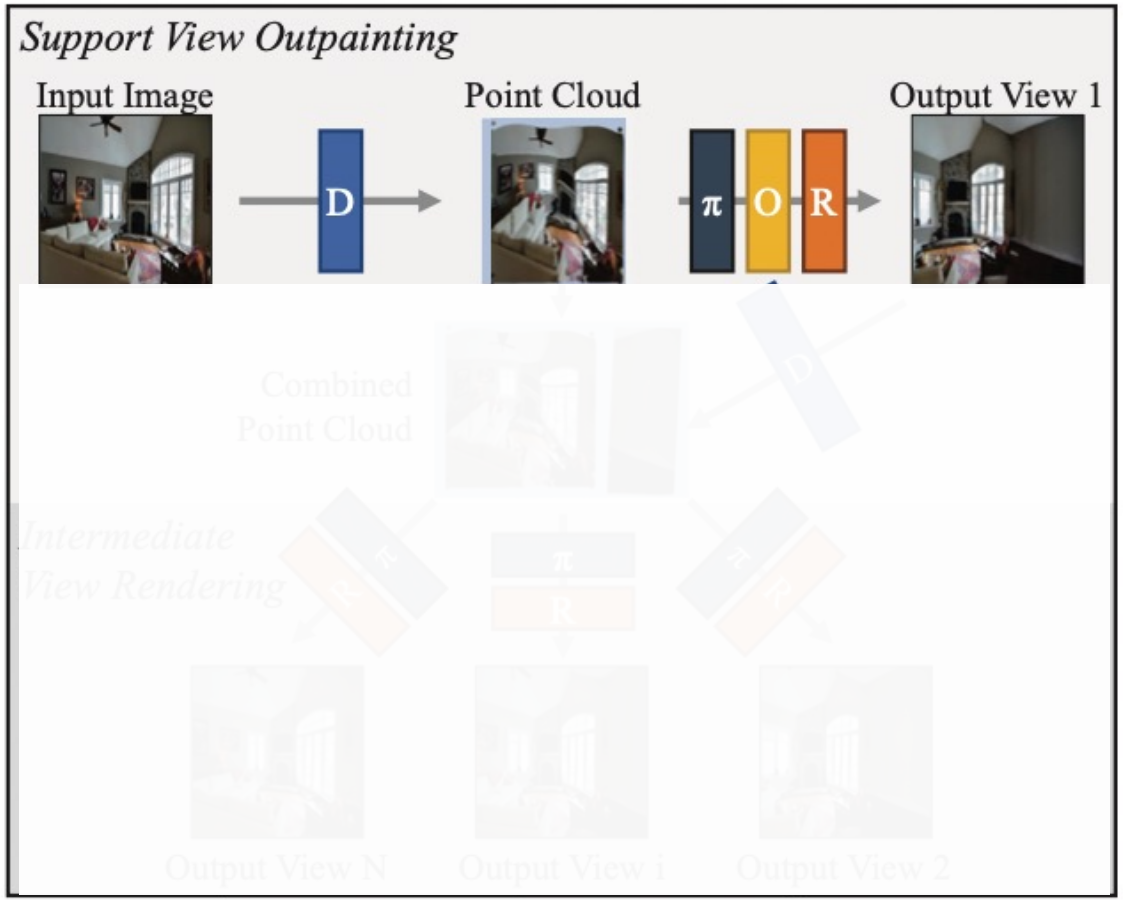

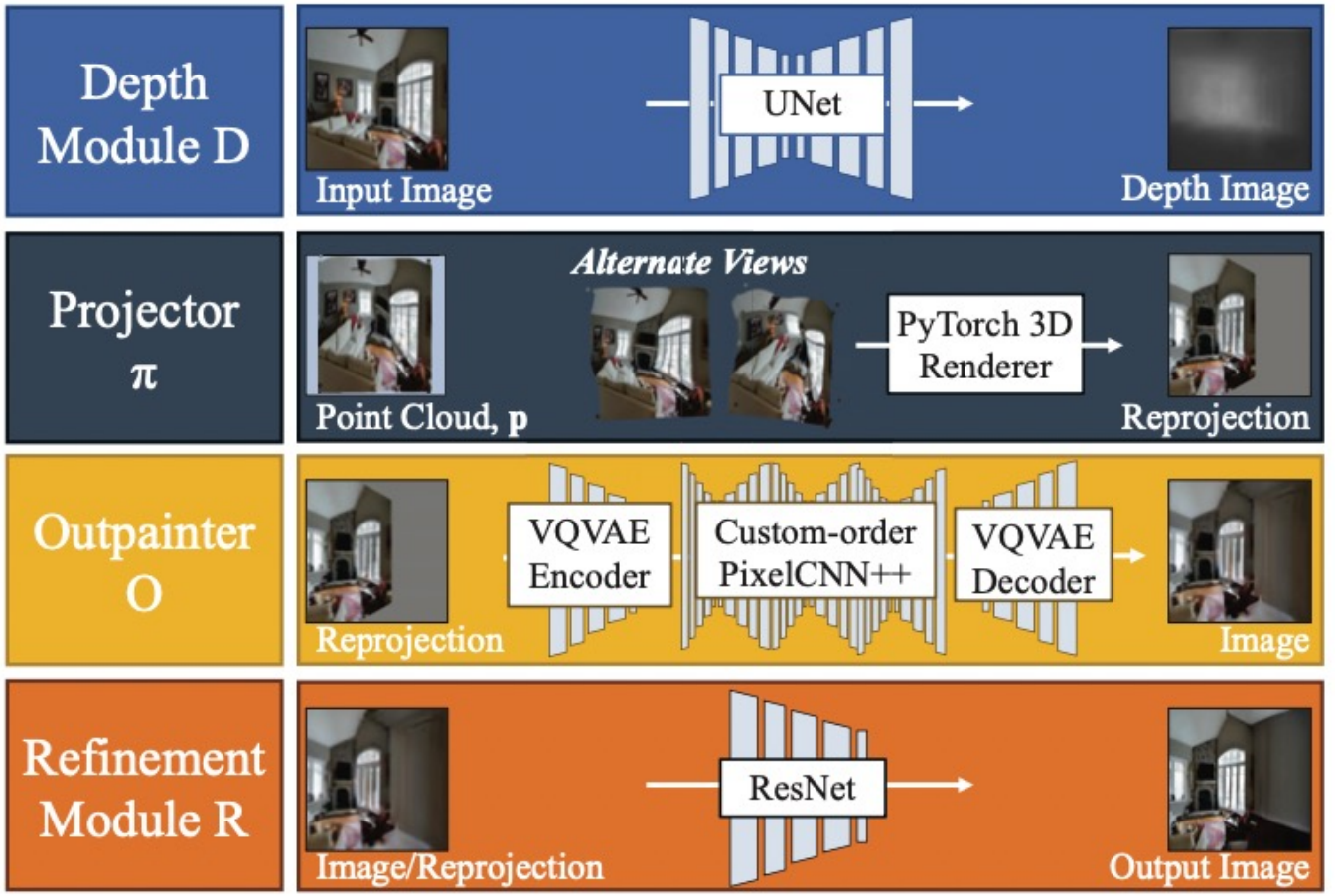

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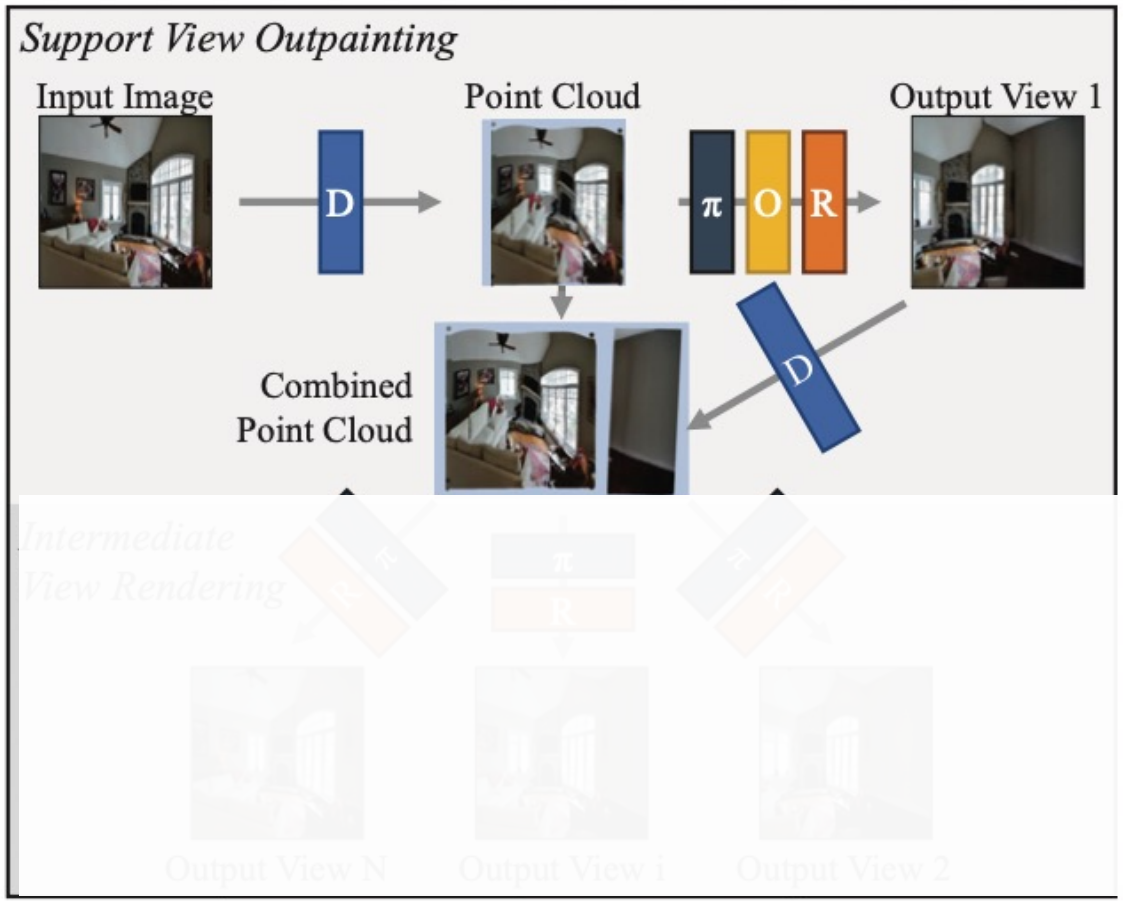

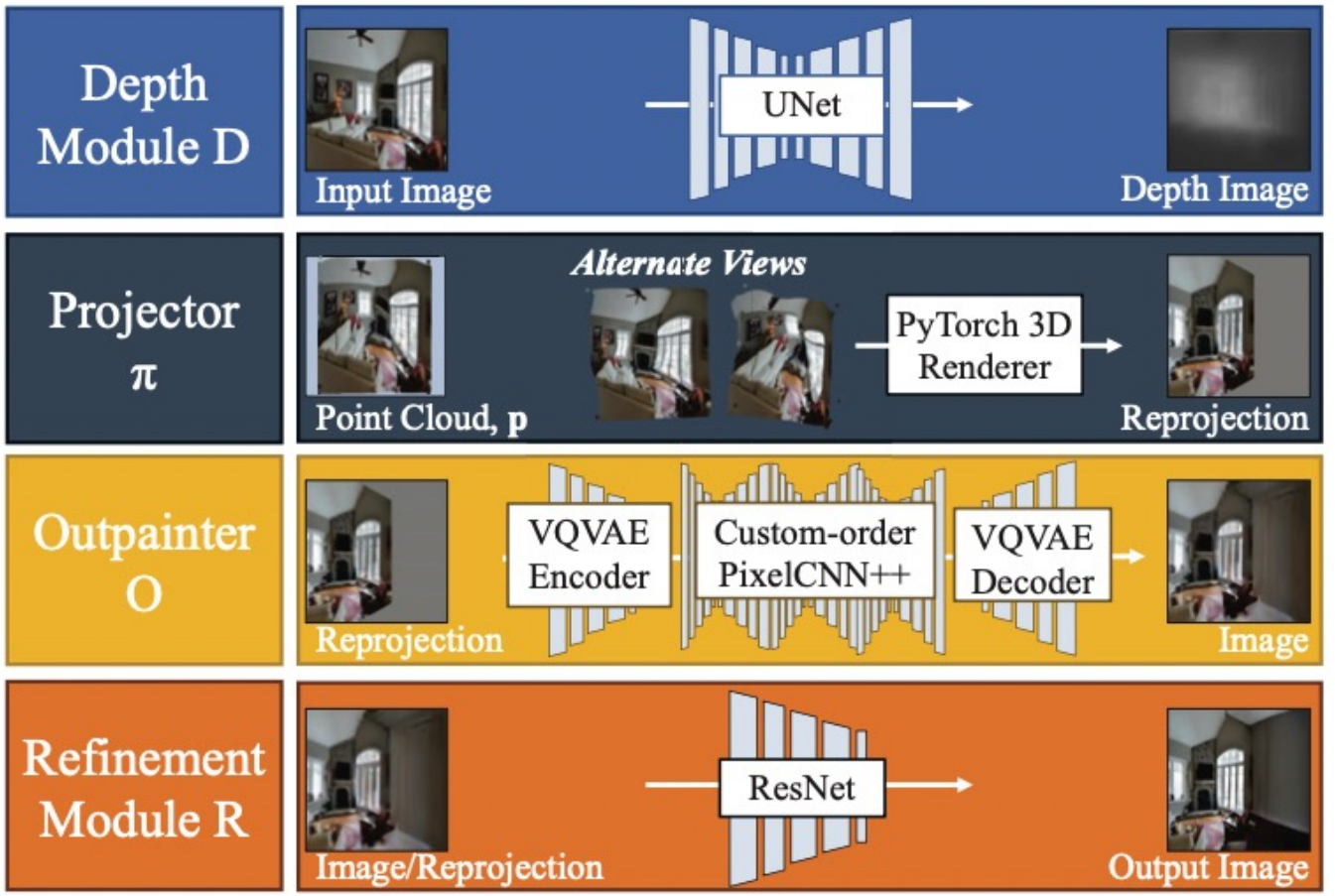

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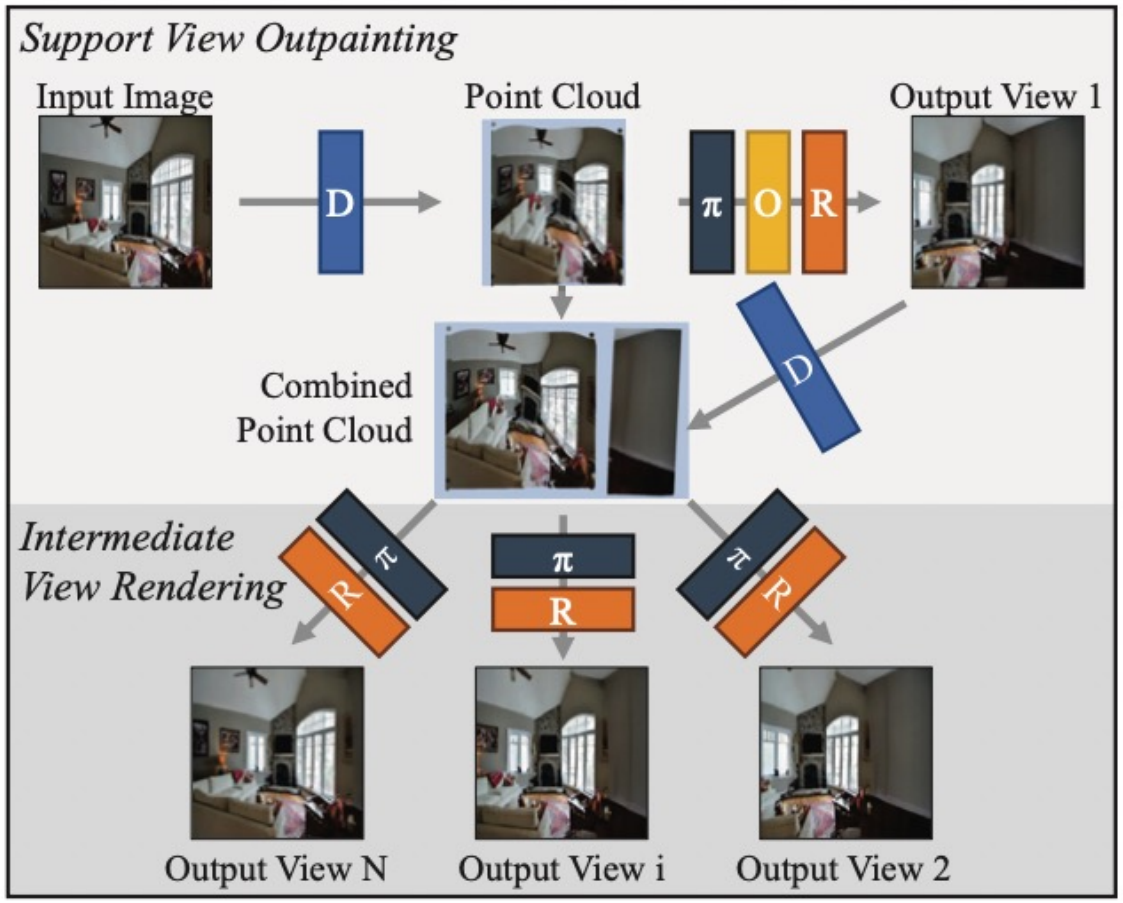
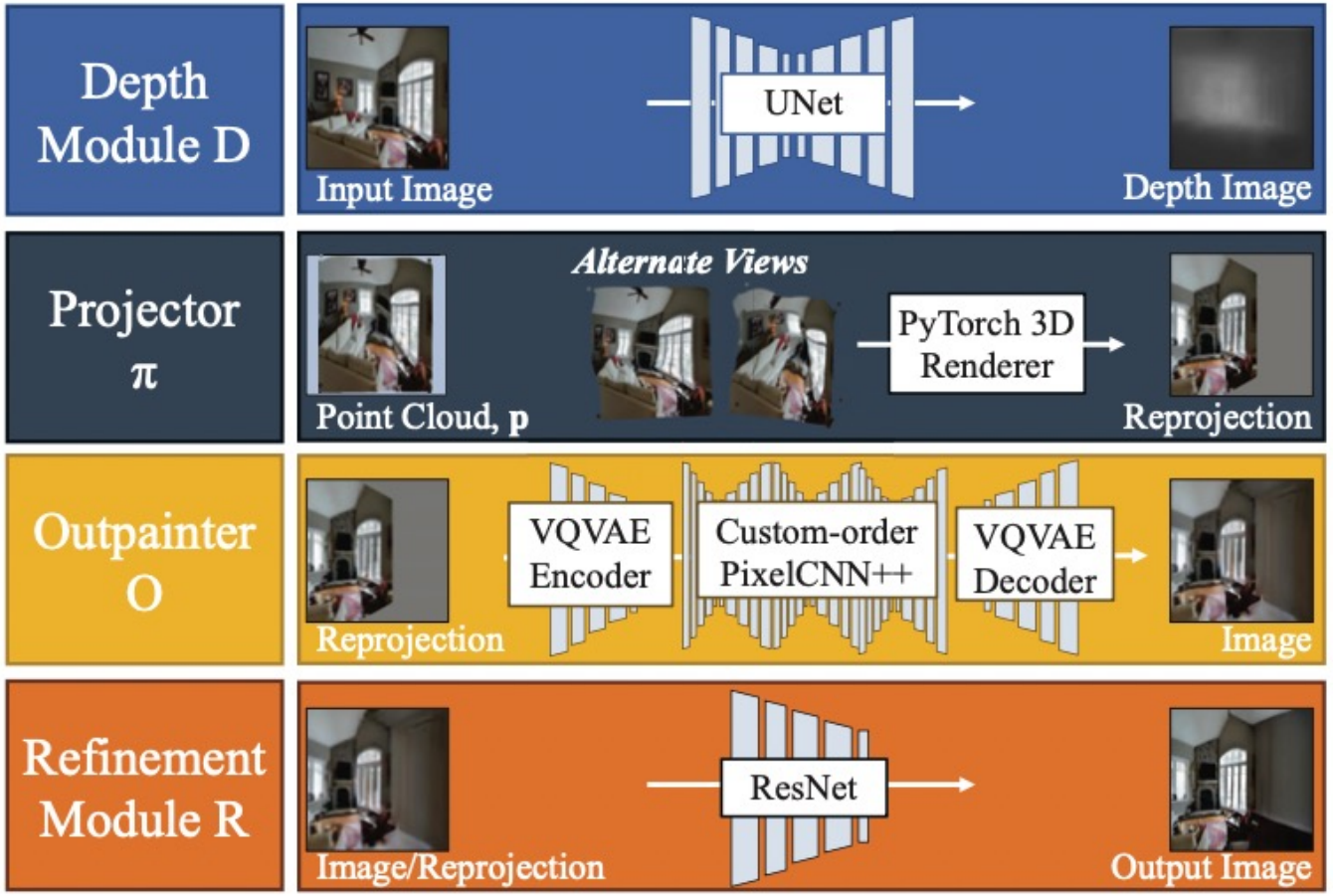




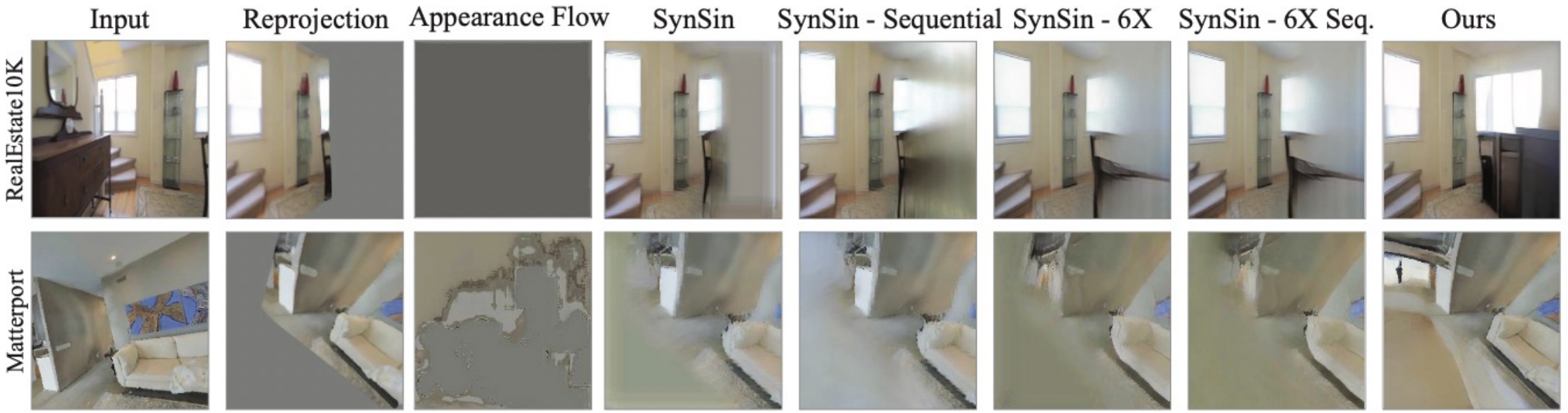
Introduction

Network

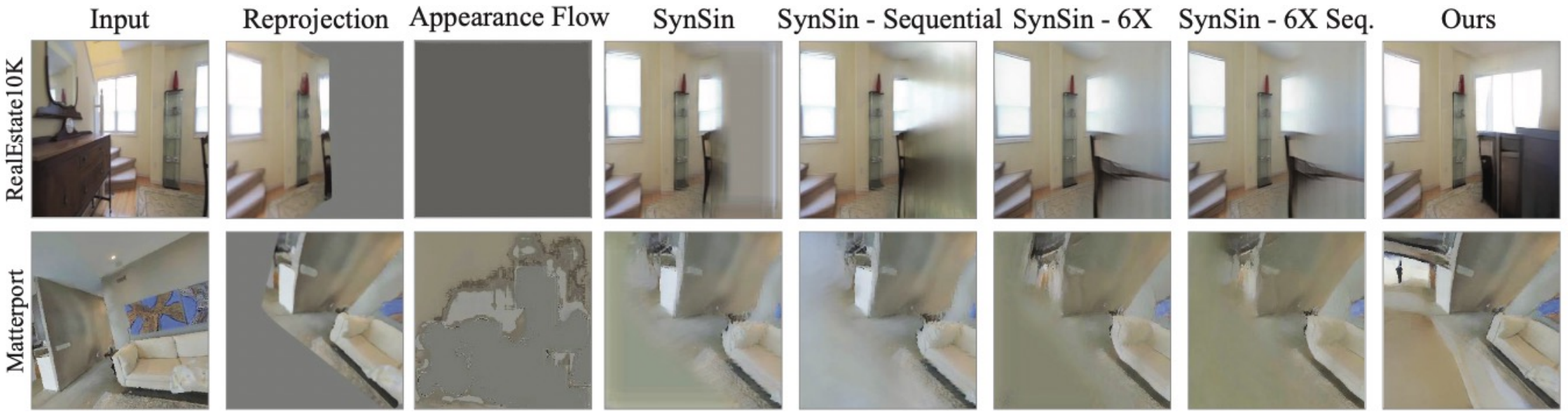
Experiments

Conclusion

Experiments

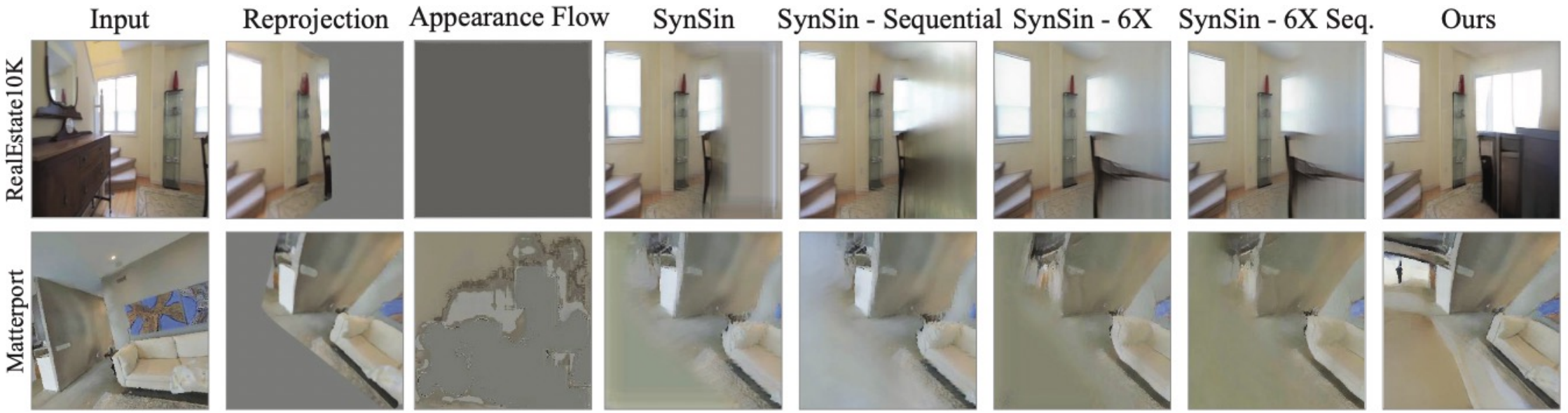


Experiments



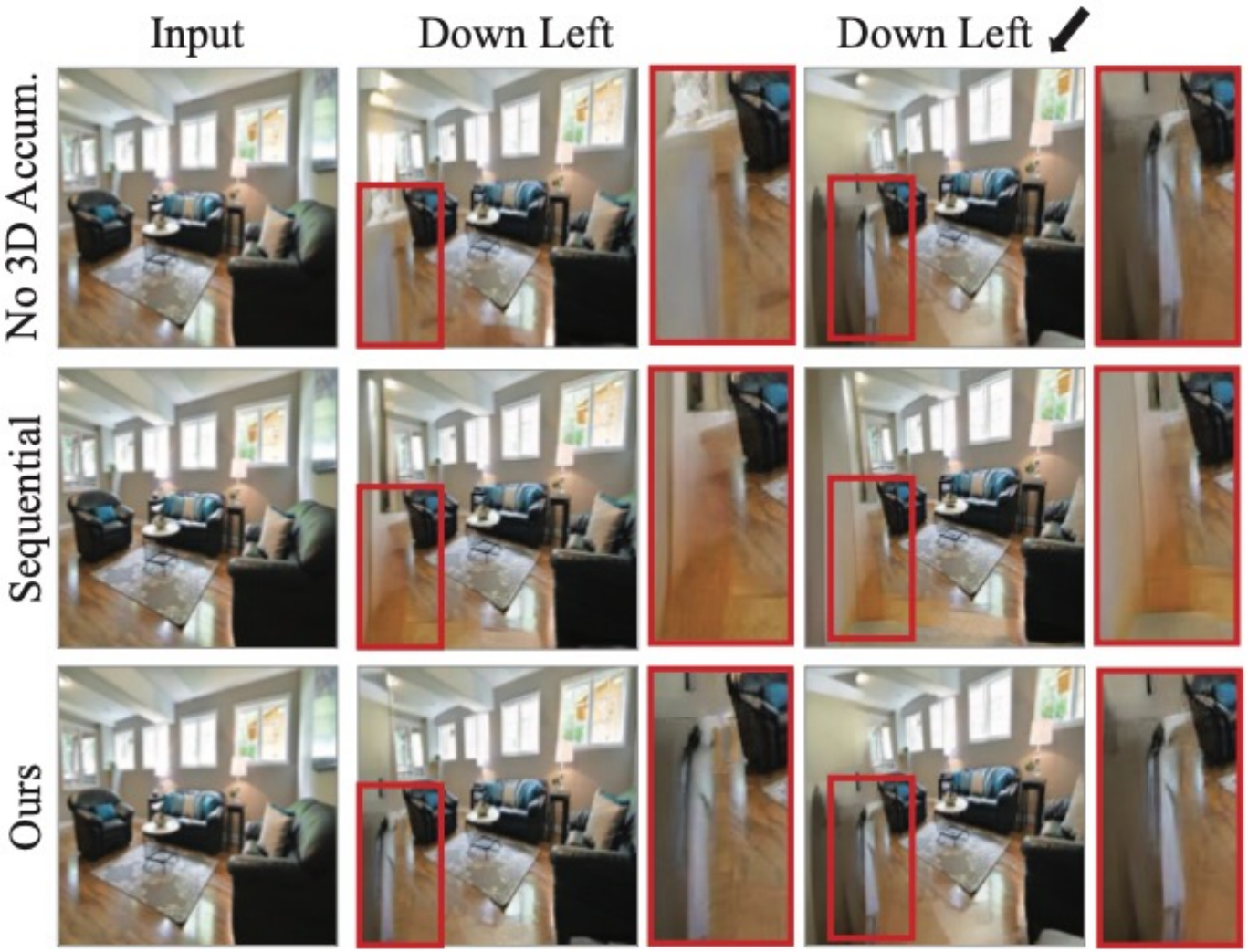
Method	Matterport		RealEstate	
	A/B ↑	FID ↓	A/B ↑	FID ↓
Tatarchenko *et al.* [45]	0.0%	427.0	0.0%	256.6
Appearance Flow [64]	19.8%	95.8	1.9%	248.3
Single-View MPI [47]	-	-	2.7%	74.8
SynSin [53]	14.8%	72.0	5.8%	34.7
SynSin - Sequential	19.5%	77.8	11.5%	34.9
SynSin - 6X	27.3%	70.4	22.0%	27.9
SynSin - 6X, Sequential	21.2%	79.3	14.4%	33.1
Ours	-	56.4	-	25.5

Experiments



Method	Matterport		RealEstate10K	
	PSNR ↑	Perc Sim ↓	PSNR ↑	Perc Sim ↓
Tatarchenko *et al.* [45]	13.72	3.82	10.63	3.98
Appearance Flow [64]	13.16	3.68	11.95	3.95
Single-View MPI [47]	-	-	12.73	3.45
SynSin - 6X, Sequential	15.61	3.17	14.21	2.73
Ours	14.60	3.17	13.10	2.88

Experiments



Method	A/B vs. Ours ↑ Matterport	RealEstate10K
No 3D Accumulation	22.6%	7.5%
Sequential Generation	44.0%	36.2%
Ours	-	-

Introduction

Network

Experiments

Conclusion

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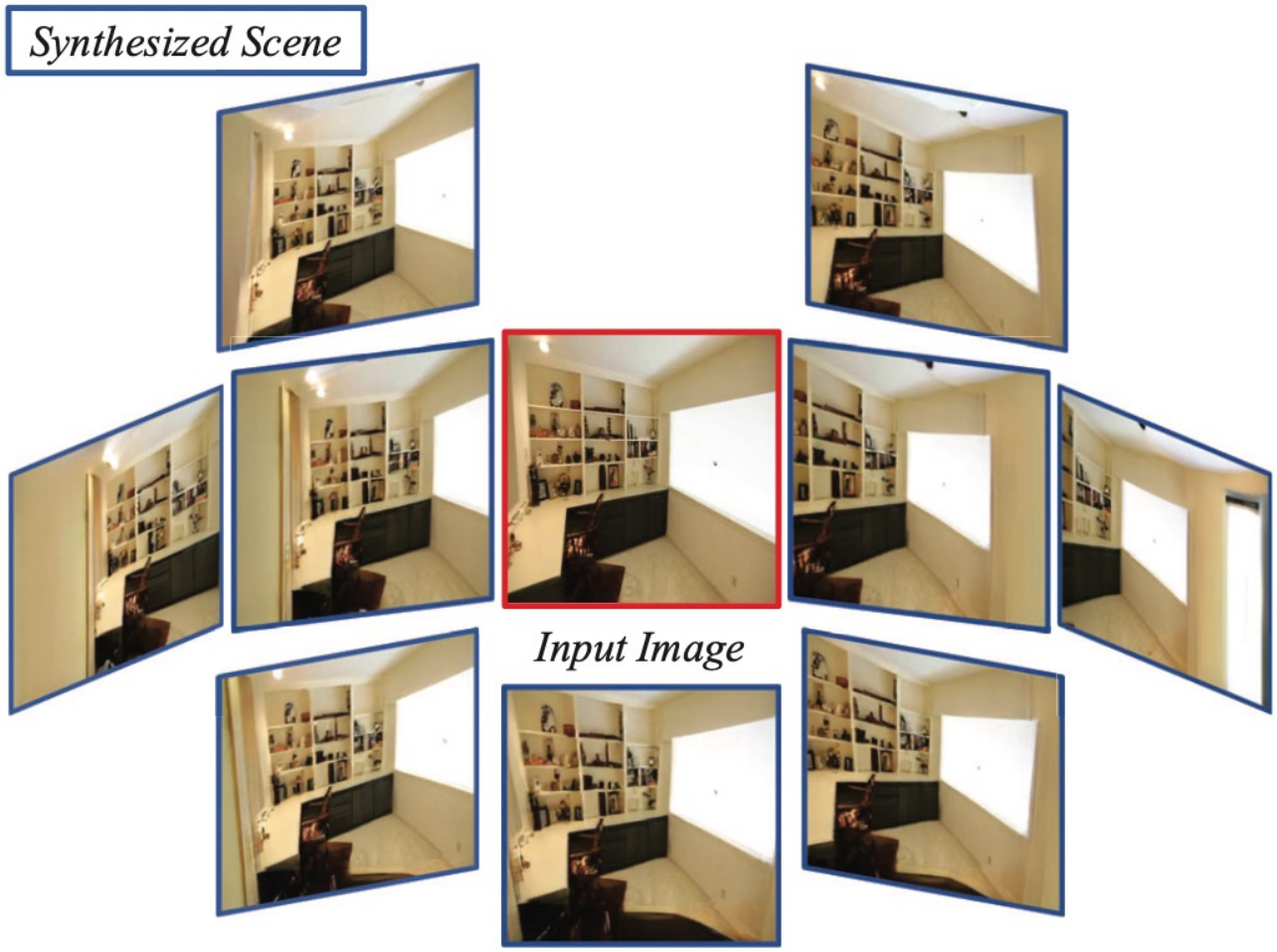

Chris at al., PixelSynth: Generating a 3D-Consistent Experience from a Single Image ,ICCV 2021