



# 3D Photography using Context-aware Layered Depth inpainting

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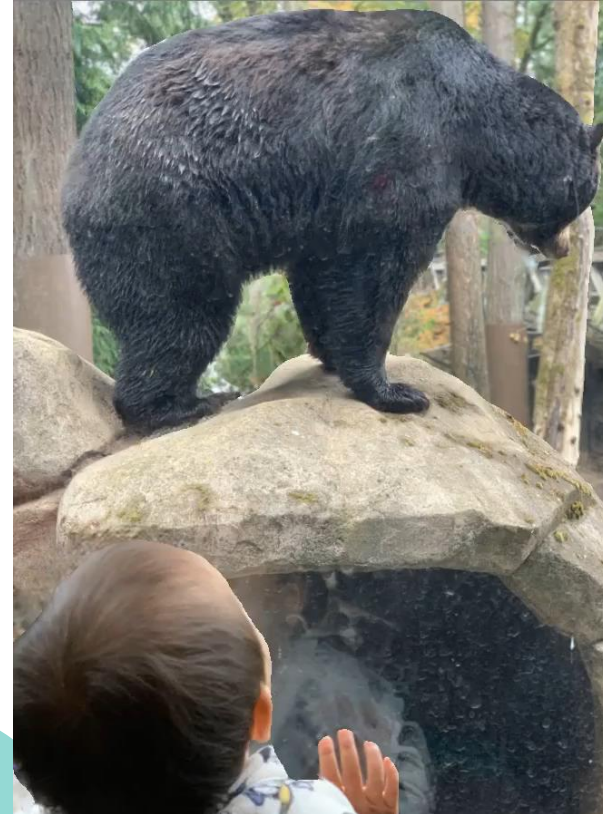
# Outline

1. Introduction
2. Related Work
3. Method
4. Result
5. Conclusion

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- 1. Introduction**
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# Introduction

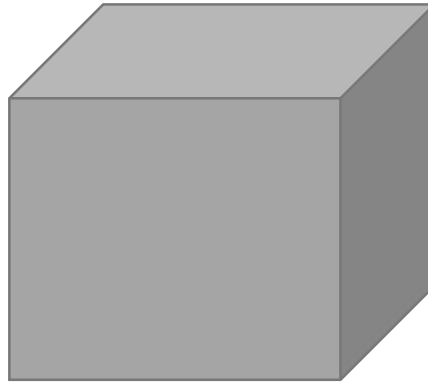


# Introduction

2D



3D



- Immersive experience
- More Application

# Introduction



How to inpainting

# Outline

1. Introduction
- 2. Related Work**
3. Method
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5. Conclusion

# Related work



- Multi-plane representation
- Learning-based
- Facebook => Layered depth image (LDI)

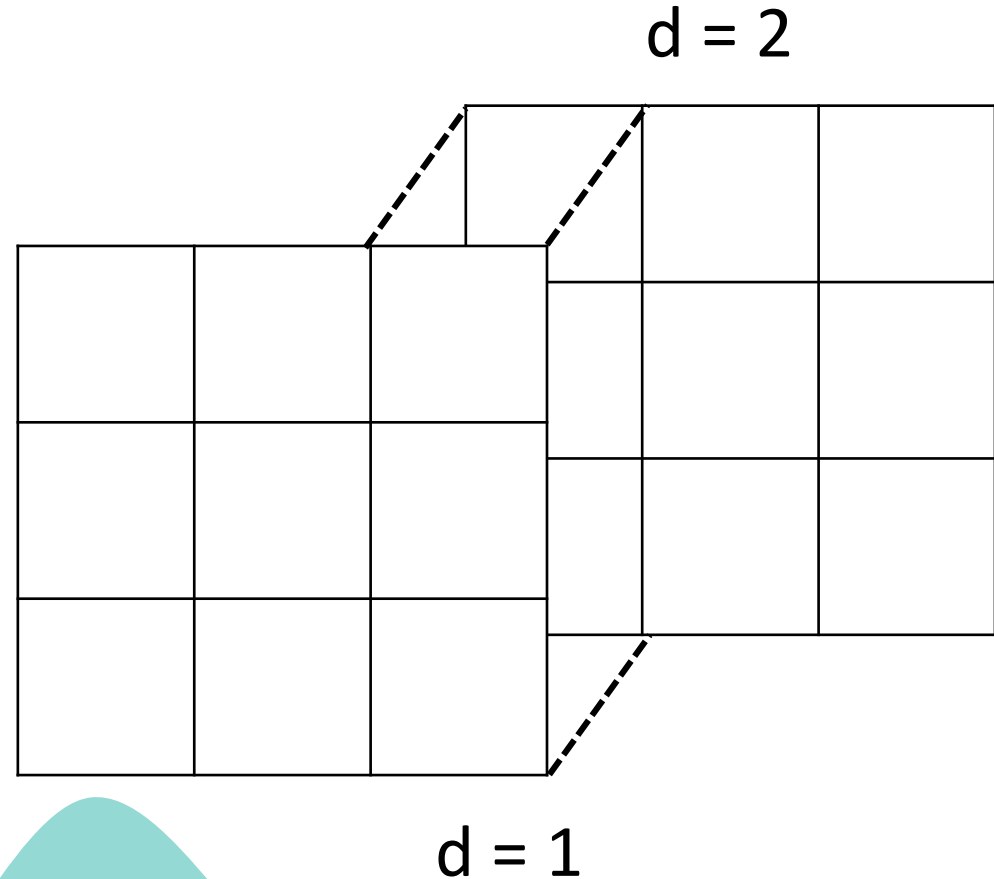


# Layered depth image (LDI)

- Color and depth value
- Holds any number of pixels

New Rule :

- No neighbors across depth discontinuities



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# Method

RGB – D data

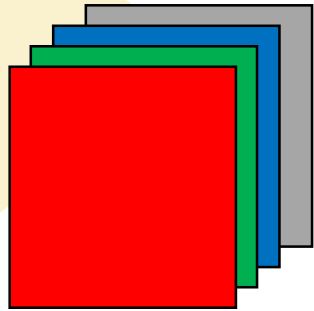


Image inpainting  
algorithm



3D photography



# Method

RGB – D data

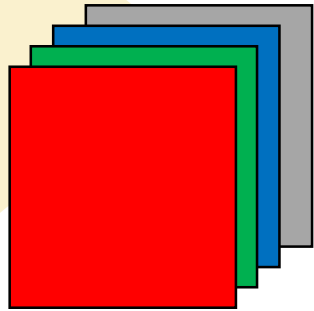


Image inpainting  
algorithm



3D photography



# Image Preprocessing

Depth map

9	10	20
5	3	30
40	50	100

Normalize  
to 0 ~ 1



0.09	0.1	0.2
0.05	0.03	0.3
0.4	0.5	1

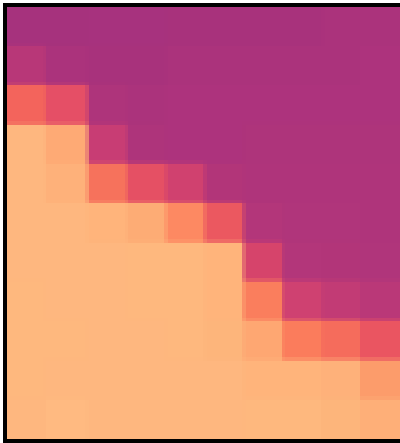


Bilateral median filter

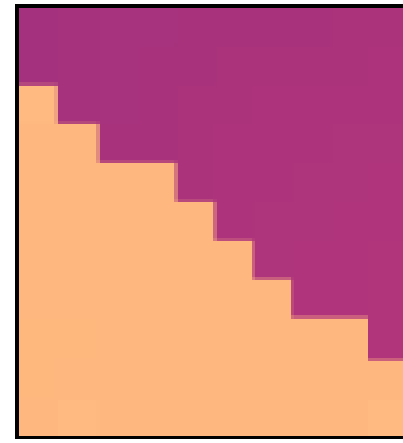
window	7 x 7
$\sigma_{\text{spatial}}$	4.0
$\sigma_{\text{intensity}}$	0.5

# Image Preprocessing

Raw



Filtered



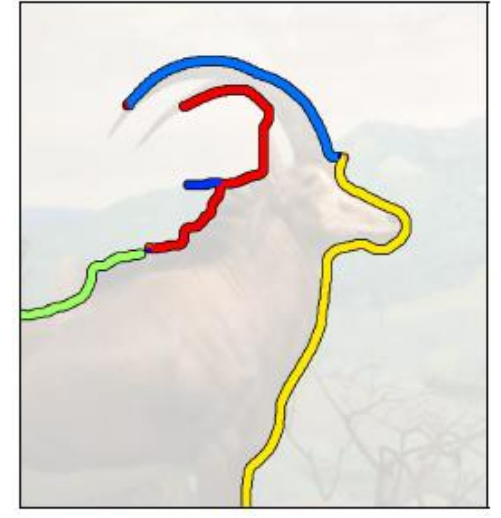
# Image Preprocessing



Threshold  
→



Check  
Connectivity  
→



# Method

RGB – D data

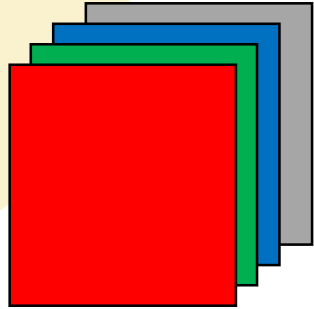
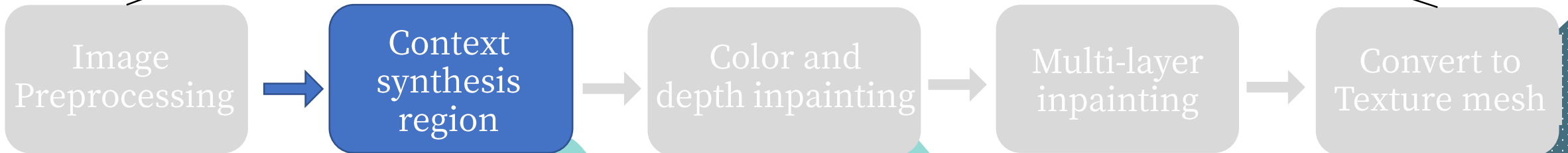


Image inpainting  
algorithm

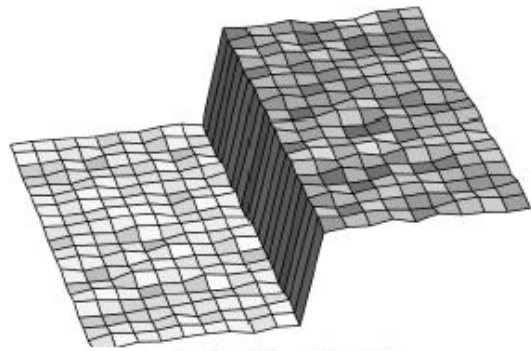


3D photography

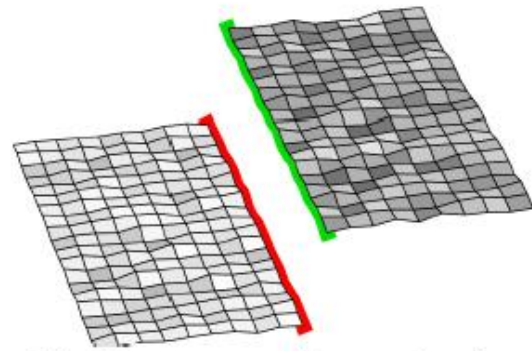




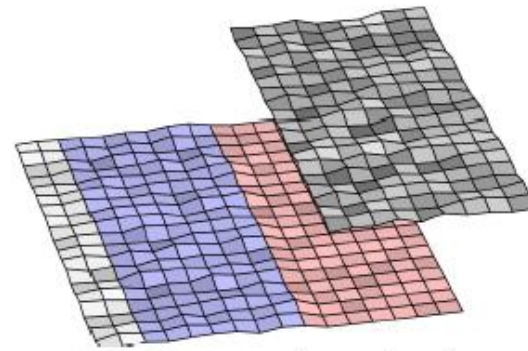
# Context and synthesis region



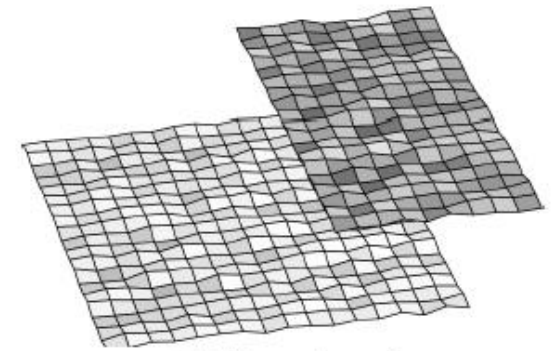
(a) Initial LDI  
(fully connected)



(b) Cut across discontinuity



(c) Context / synthesis  
regions



(d) Inpainted

# Context and synthesis region



Input

context/synthesis w/o dilation

w/ dilation

# Method

RGB – D data

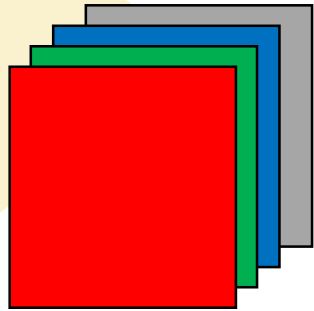


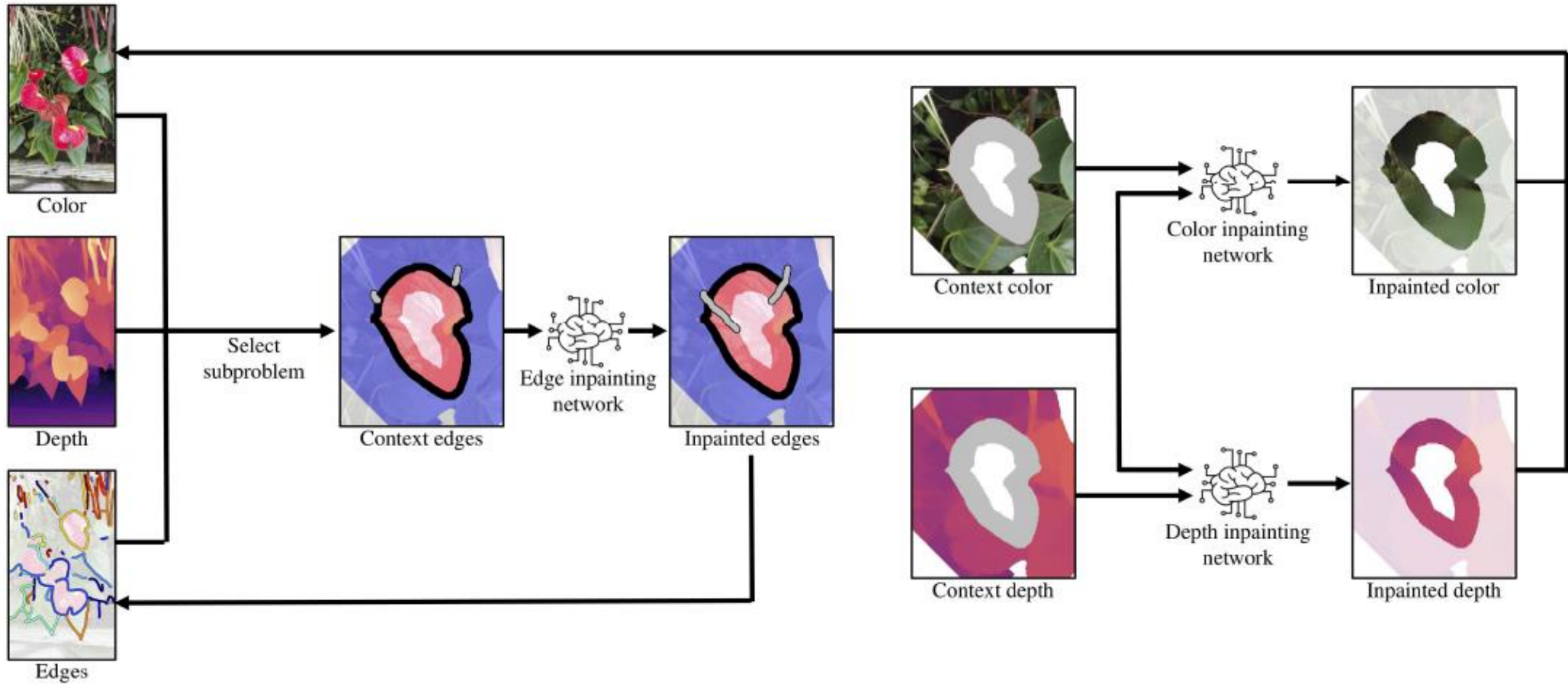
Image inpainting  
algorithm



3D photography



# Color and depth inpainting



# Color and depth inpainting

- Edge inpainting network : GAN
- Depth inpainting network : U-net
- Color inpainting network : U-net

$$L = L_{context} + 6L_{synthesis} + 0.05L_{perceptual} + 120L_{style} + 0.01L_{tv} \rightarrow \text{Color inpainting loss}$$

↓  
Depth inpainting loss

# Method

RGB – D data

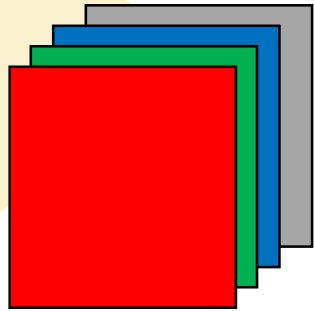


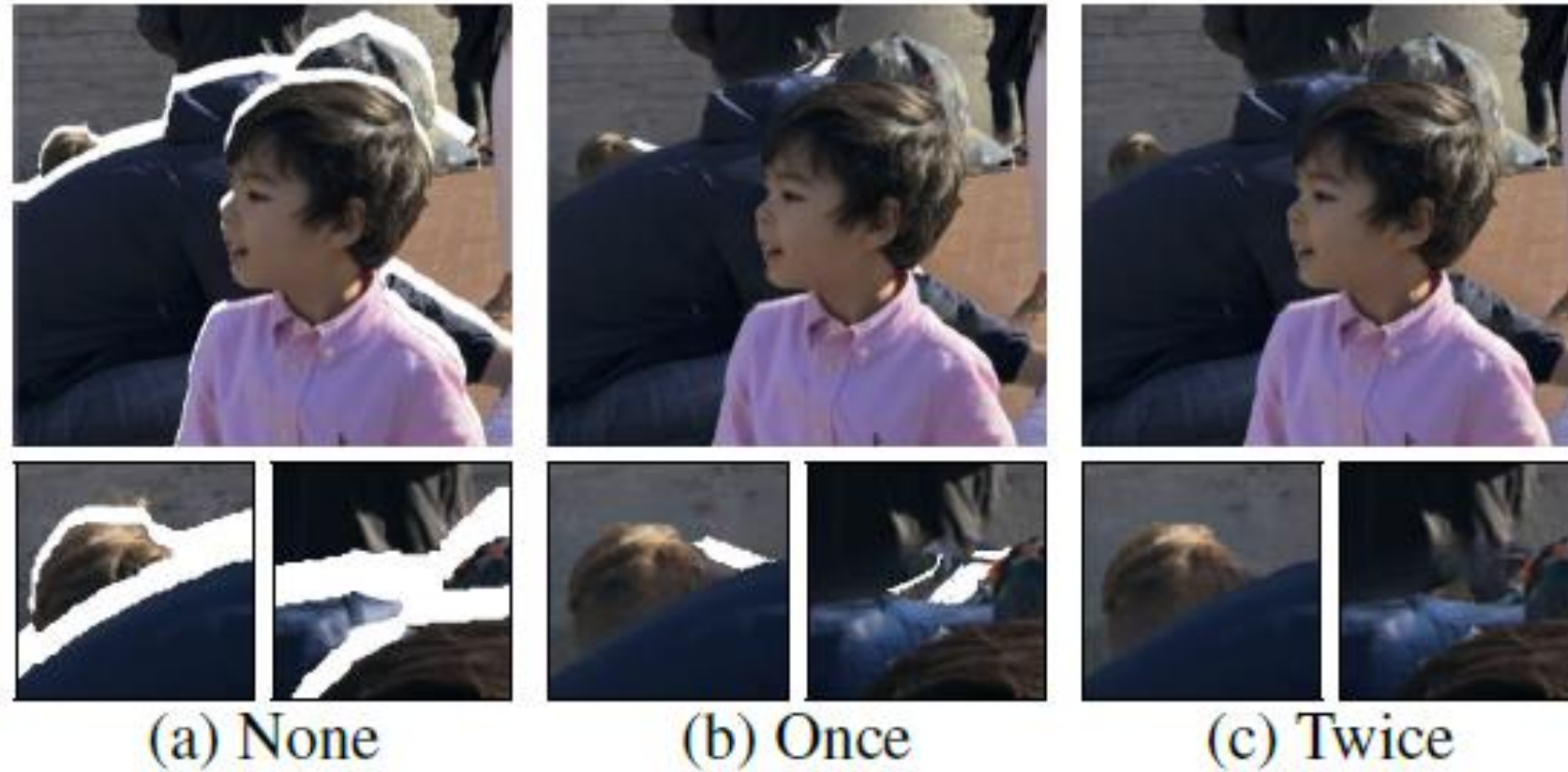
Image inpainting  
algorithm



3D photography



# Multi-layer inpainting



# Method

RGB – D data

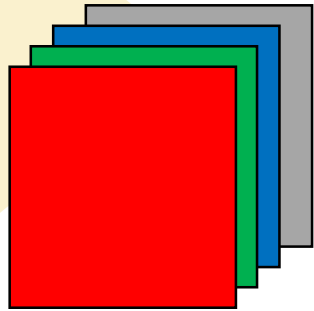
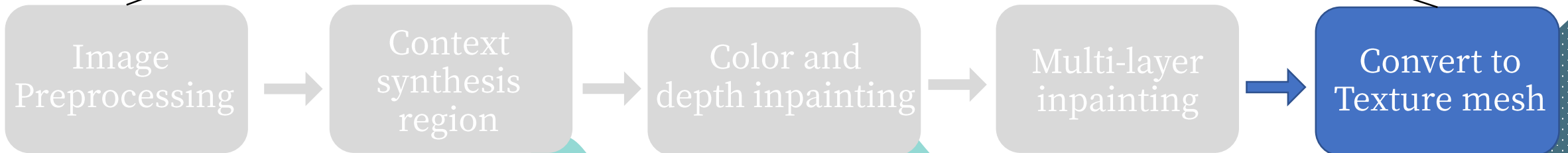


Image inpainting  
algorithm



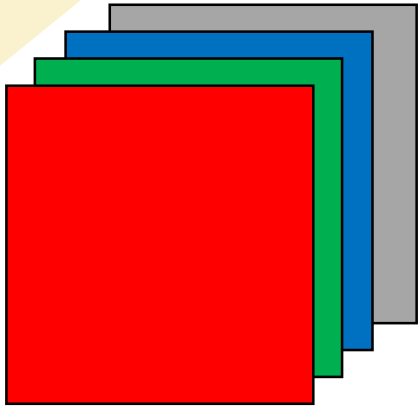
3D photography



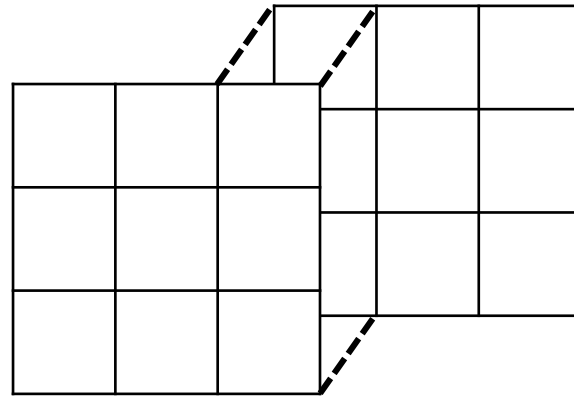


# Convert to texture mesh

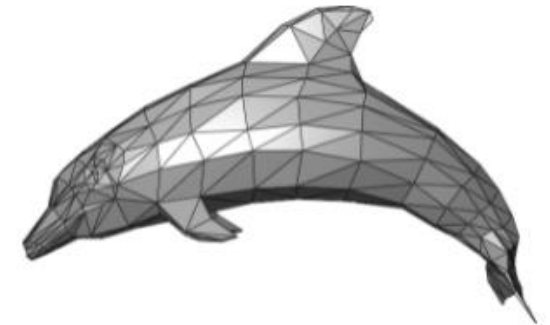
RGB – D data



LDI image



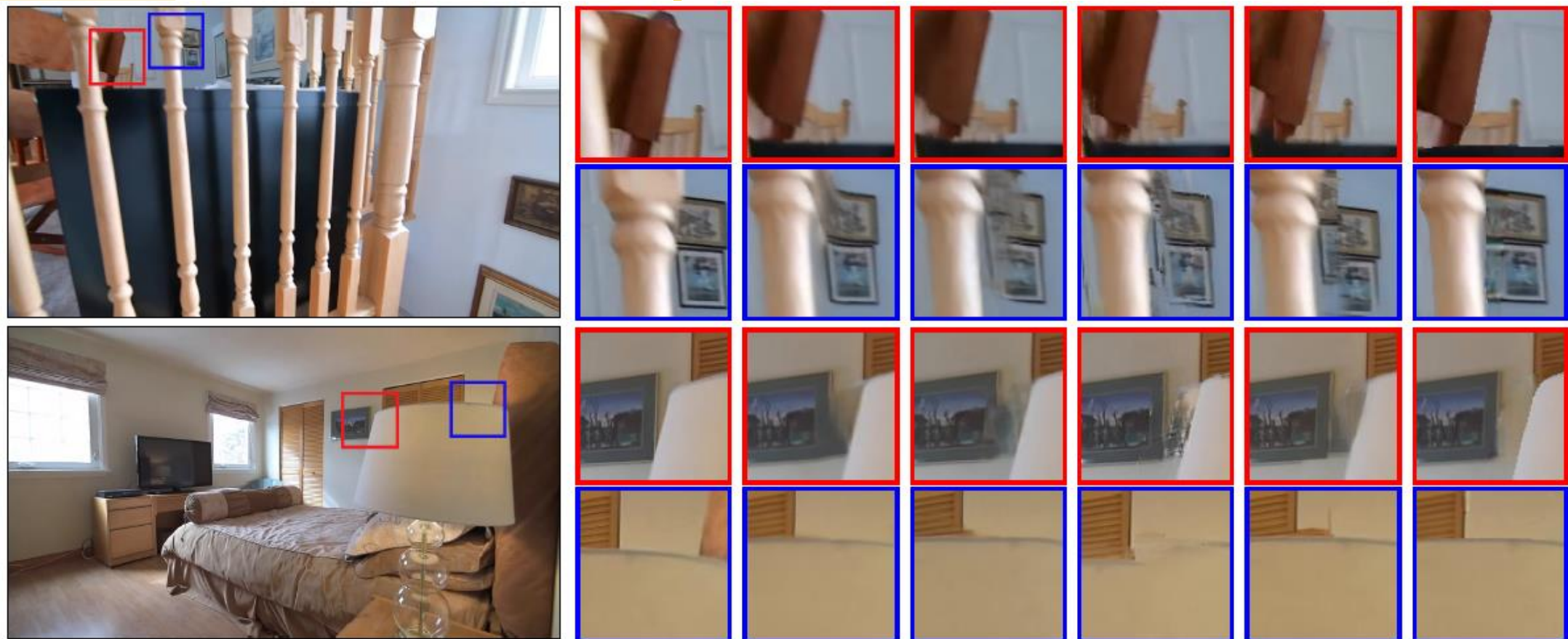
Mesh representation



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# Result



Reference Frame

Zoom-in

StereoMag [72] PB-MPI [52]

LLFF [39]

XView [4]

Ours

# Result



Facebook 3D Photo results



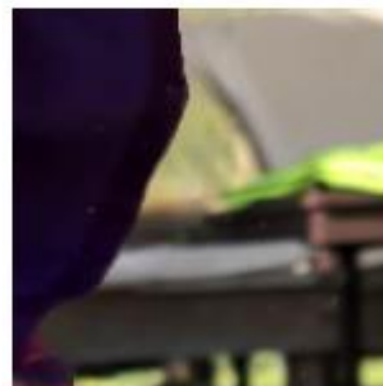
Our results

# Result

Facebook



Proposed



# Result

Table 1. **Quantitative comparison** on the RealEstate10K dataset.

Methods	SSIM $\uparrow$	PSNR $\uparrow$	LPIPS $\downarrow$
Stereo-Mag [72]	<b>0.8906</b>	26.71	0.0826
PB-MPI [52]	0.8773	25.51	0.0902
LLFF [39]	0.8062	23.17	0.1323
Xview [4]	0.8628	24.75	0.0822
Ours	0.8887	<b>27.29</b>	<b>0.0724</b>

# Result

Table 2. Using depth edge as guidance improves the results.

Blue: results in disoccluded regions.

Methods	SSIM $\uparrow$	PSNR $\uparrow$	LPIPS $\downarrow$
Diffusion	0.8665 (0.6237)	25.95 (18.91)	0.084
Inpaint w/o edge	0.8665 (0.6247)	25.96 (18.94)	0.084
Inpaint w/ edge (Ours)	0.8666 (0.6265)	25.97 (18.98)	0.083

Table 3. Using color inpainting model gives better perceptual quality. Our dilation heuristic further boosts the performance.

Blue: results in disoccluded regions.

Methods	SSIM $\uparrow$	PSNR $\uparrow$	LPIPS $\downarrow$
Diffusion	0.8661 (0.6215)	25.90 (18.78)	0.088
Inpaint w/o dilation	0.8643 (0.5573)	25.56 (17.14)	0.085
Inpaint w/ dilation (Ours)	0.8666 (0.6265)	25.97 (18.98)	0.083



(a) Disocclusion

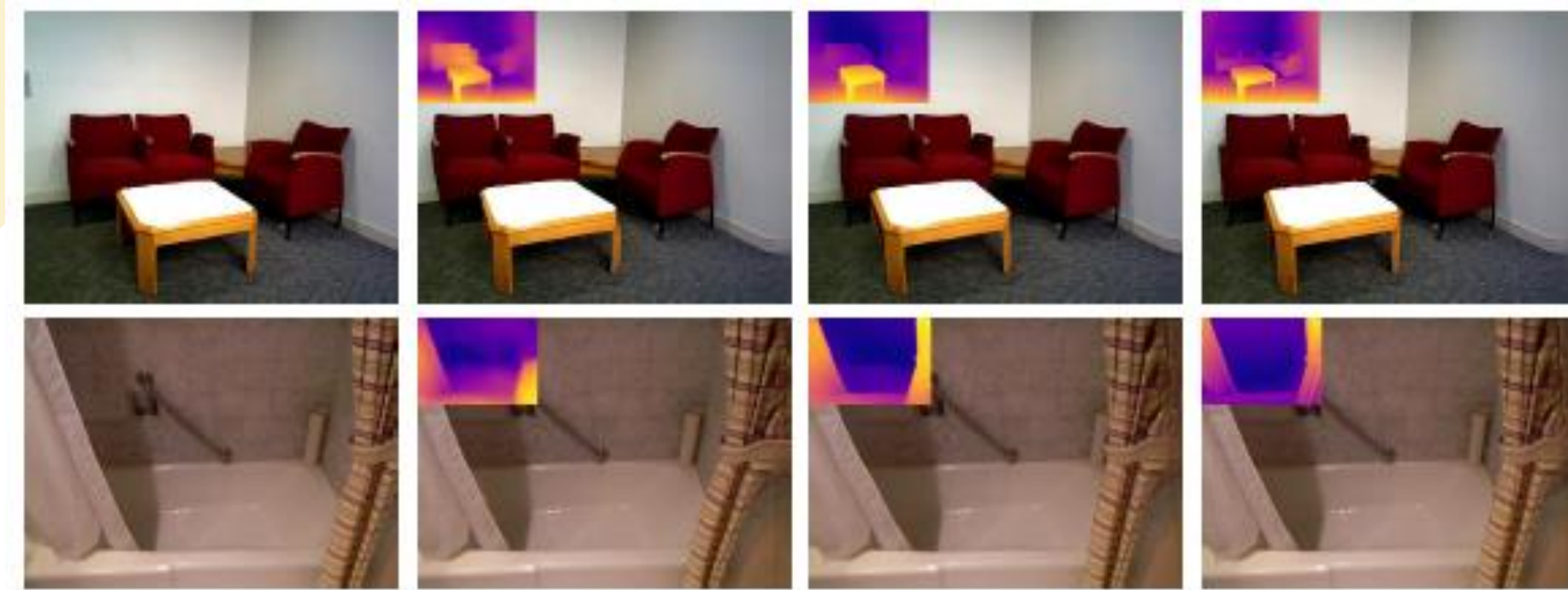
(b) Diffusion



(c) w/o Dilation

(d) w/ Dilation

# Result



Input

MegaDepth

MiDas

Kinect



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# Conclusion

- Proposed an algorithm to create 3D photography from RGB-D image
- Created layered depth image representation through context-aware color and depth inpainting
- Applied edge inpainting network to inpaint occlusion edges
- Produced fewer artifacts when compared with other techniques

# Reference

1. 3D Photography using Context-aware Layered Depth Inpainting. Meng-Li Shih, Shih-Yang Su, Johannes Kopf, Jia-Bin Huang. CVPR, 2020.
2. EdgeConnect: Generative Image Inpainting with Adversarial Edge Learning. Kamyar Nazari, Eric Ng, Tony Joseph, Faisal Z. Qureshi, Mehran Ebrahimi. ICCV, 2019.
3. The unreasonable effectiveness of deep features as a perceptual metric. In *CVPR*, 2018



Thank you !