Neural Rendering for Transparent Objects

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Motivation

- Novel view synthesis
- 3D reconstruction
  - Not accurate enough
  - Transparency
- Deferred Neural Rendering

Problem Statement

Novel-view synthesis given poses and geometry

Transparent objects

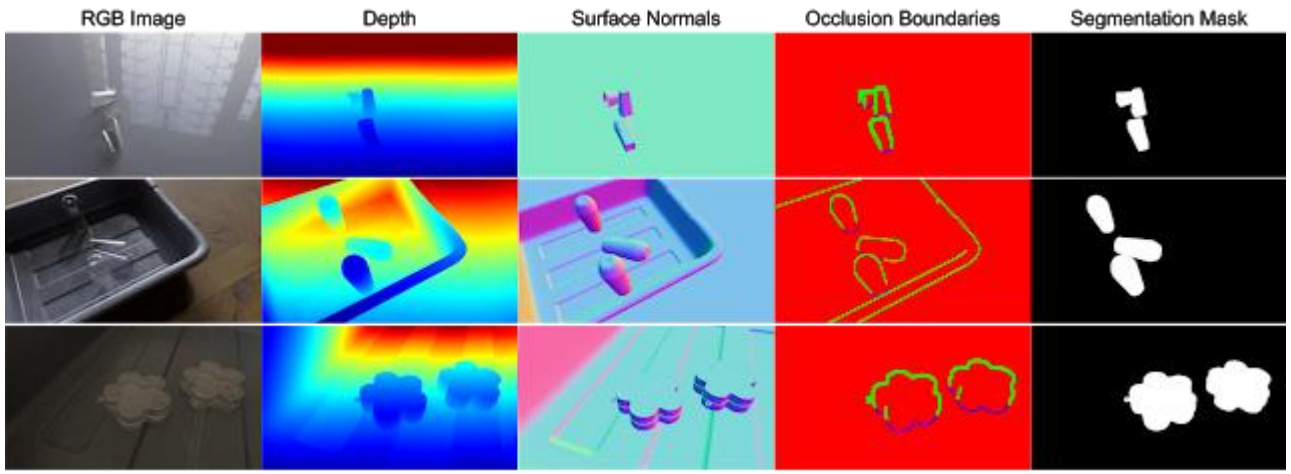
Coarse geometry

Reconstruction

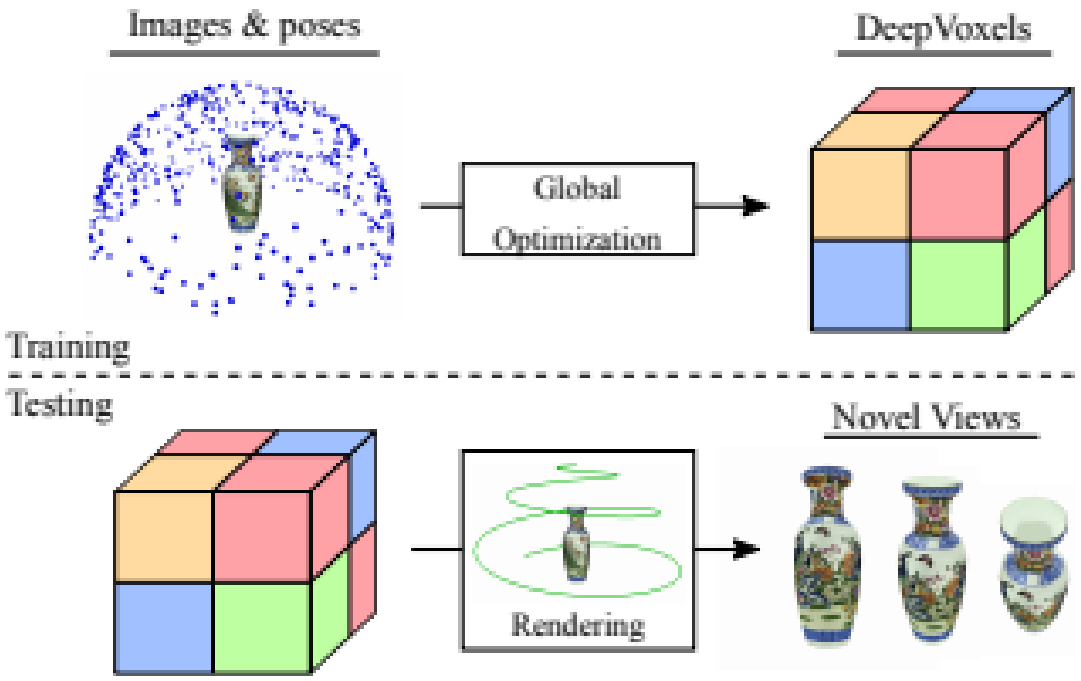
- Colmap (BundleAdjustment)
- Fails completely
  - Transparency
  - View-dependent effects

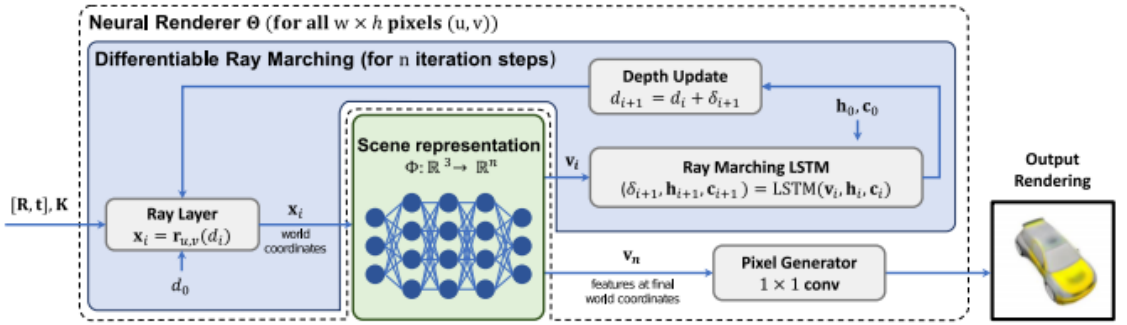
Reconstruction - ClearGrasp

ClearGrasp: 3D Shape Estimation of Transparent Objects for Manipulation, Sajjan 2019



DeepVoxels and SRN

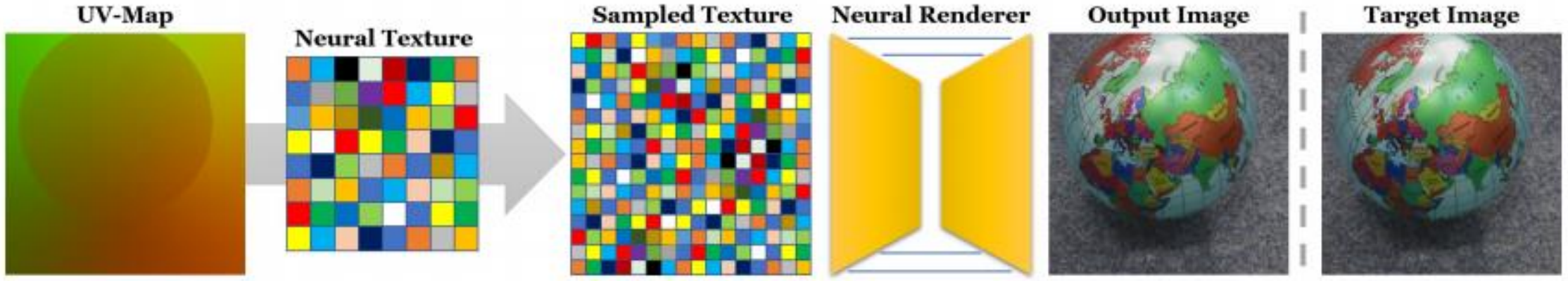




Neural Radiance Fields (NERFs)

- (x,y,z,θ,ϕ) ➔RGBα
- Volume rendering

Deferred Neural Rendering



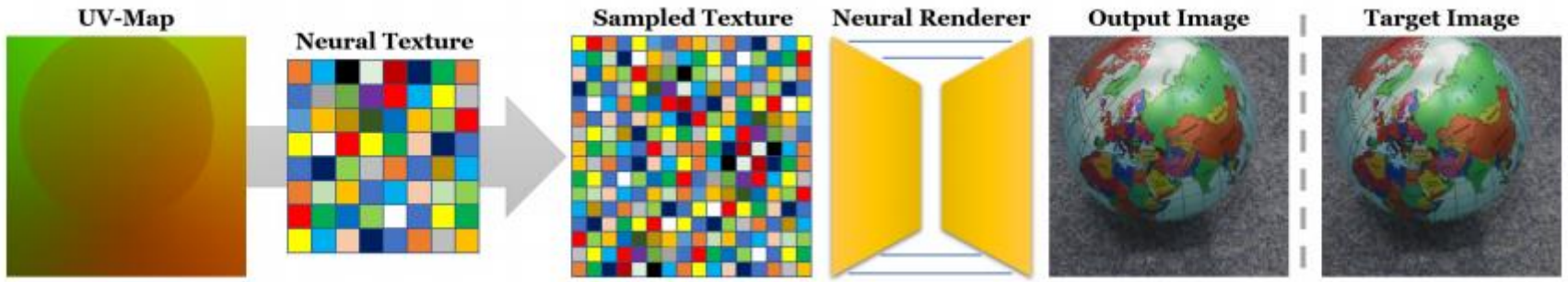
Novel-view synthesis given poses and geometry

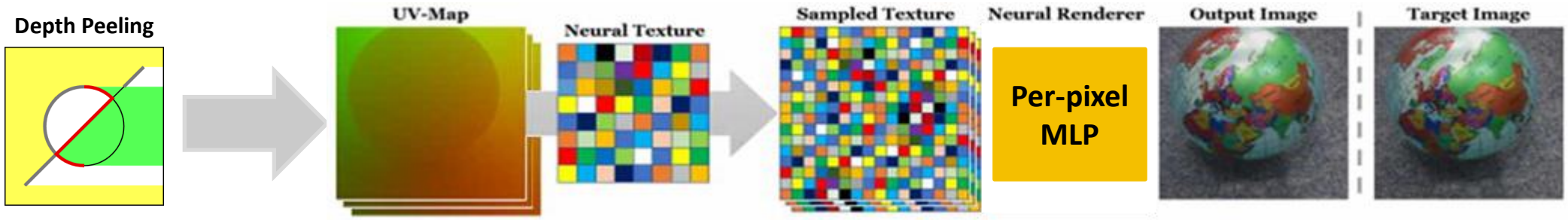
~~Transparent objects~~

Coarse geometry

Deferred Neural Rendering

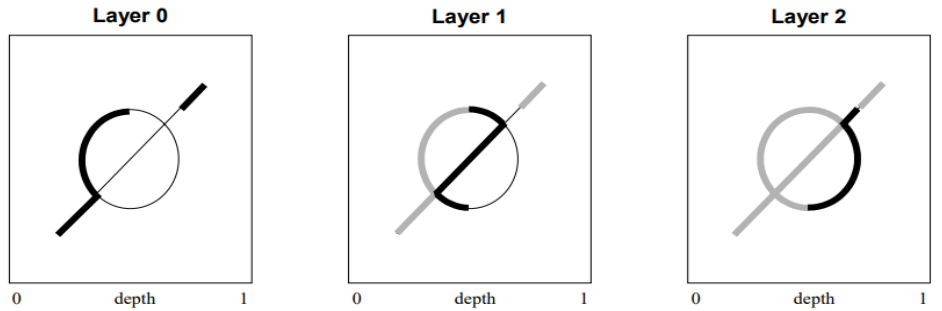
Concept

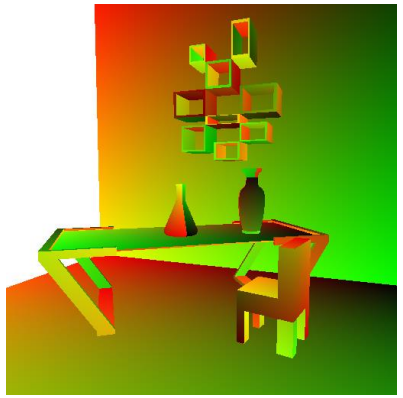

UV-Map
Neural Texture
Sampled Texture
Neural Renderer
Output Image
Target Image

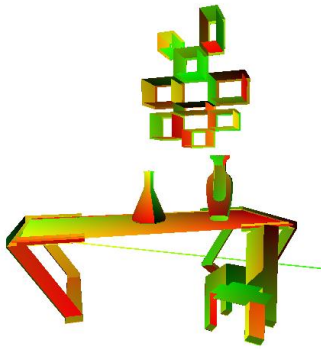

Depth Peeling
UV-Map
Neural Texture
Sampled Texture
Neural Renderer
Per-pixel MLP
Output Image
Target Image

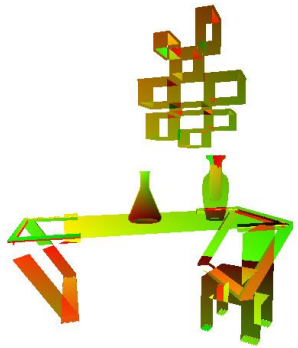
Depth Peeling

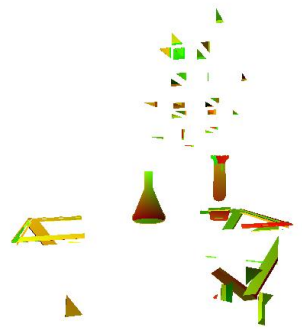
- Order independent transparency
- Render transparent scene multiple times
  - Depth write and depth > previous depth
- Store uv-layers for neural rendering





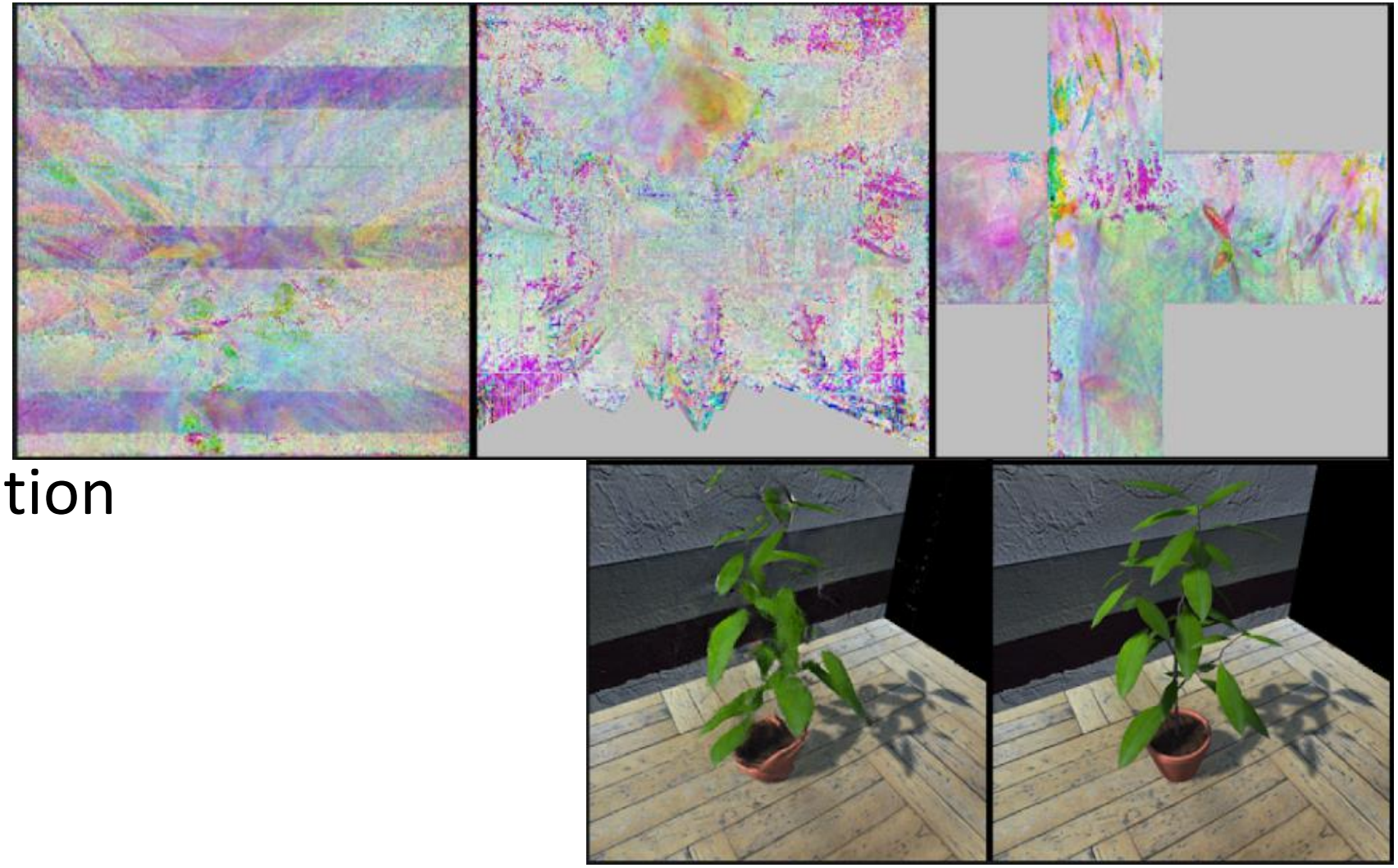






Neural Textures

- Local properties
  - Color
  - Normals
  - Opacity
  - etc.
- Bi-Linear interpolation



Renderer Architecture

U-net

- Overfitting → interpolating
- 16M params
- Blurry
- Artifacts
- Focus on view-dir

PerPixel (1x1 conv ResNet)

- Better at extreme views
- 40K params
- More like classical rendering
- No inpainting

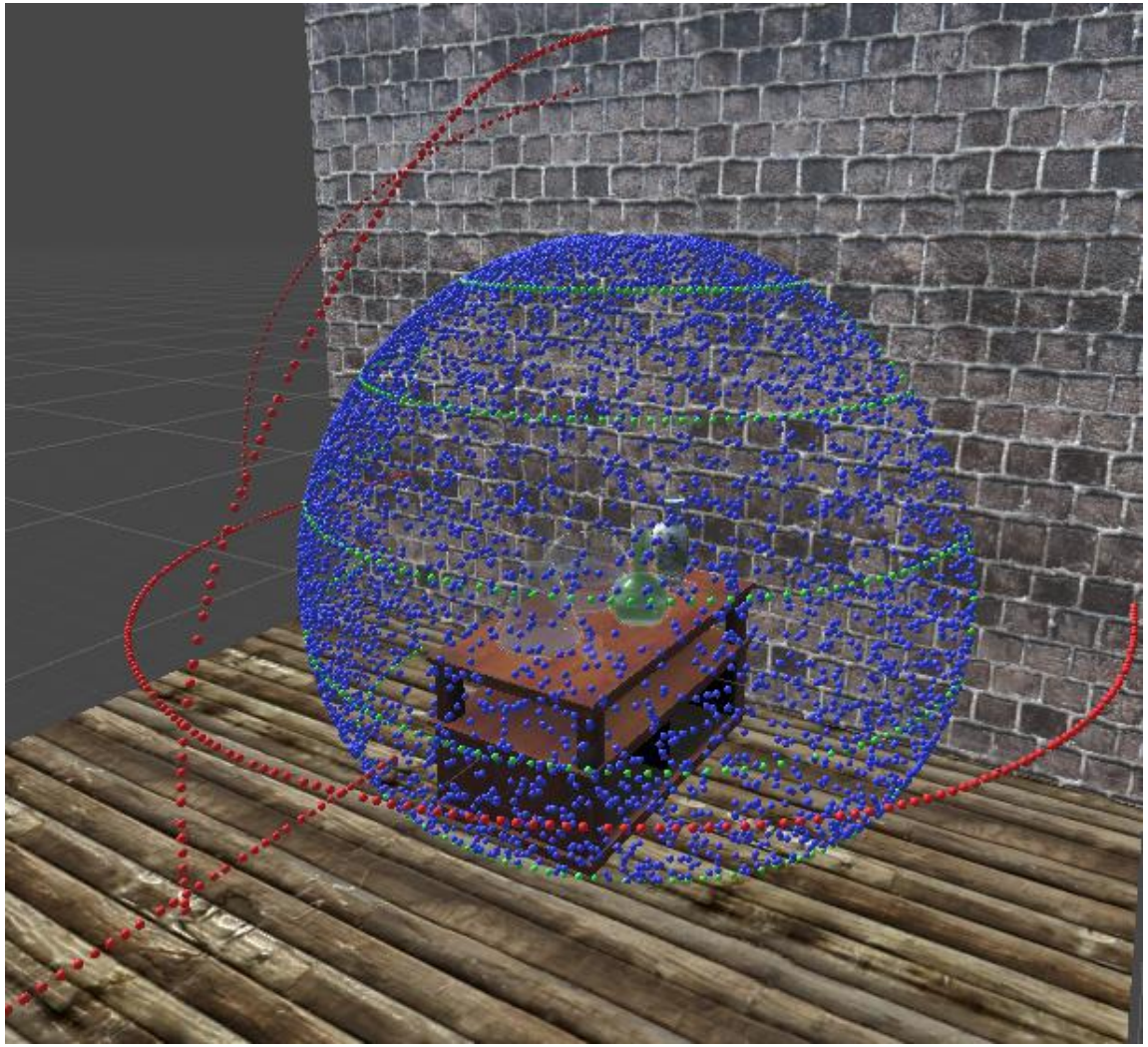
Losses

- L1
  - No highlights
- Perceptual (VGG)
  - Color

➔L1 + VGG

VGG only

Testing Methodology



- Blue: training
- Green: interpolating
- Red: extrapolating

Extrinsics

- Specular highlights are a problem
- Idea: add extrinsics to input
  - Simply as view-direction
  - Spherical Harmonics
    - Coefficients as extra texture channels

	Interpolating	Extrapolating
No extrinsics	33.09	32.96
View dir	33.19	**32.99**
SH	**33.80**	32.52

Results - interpolating

Results - extrapolating

Limitations

Conclusion

- Deferred Neural Rendering for transparent objects
- Per-pixel vs U-net
- Specular highlights don´t work
- No inpainting

Future Work

- In-the-wild testing (ClearGrasp)
- Textures for Scan2CAD
- Lighting

Questions