Capturing View-Dependent Optics in 3D Feature Embeddings

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Background

- DeepVoxels[2,3] is a 3D feature embedding for synthesizing 2D novel views.
- DeepVoxels assumes Lambertian object surfaces, but is still capable of implicitly modeling view-dependent optical effects in an imprecise way.
- An understanding of this implicit mechanism is central to introducing an explicit method for rendering specularities in synthesized views.

Objectives

- Generate a 3D understanding based on 2D renders of an object from differing viewpoints.
- When rendering novel 2D views from 3D understanding, reduce ambiguity and imprecision in DeepVoxels' ability to render view-dependent optical effects.

Dataset

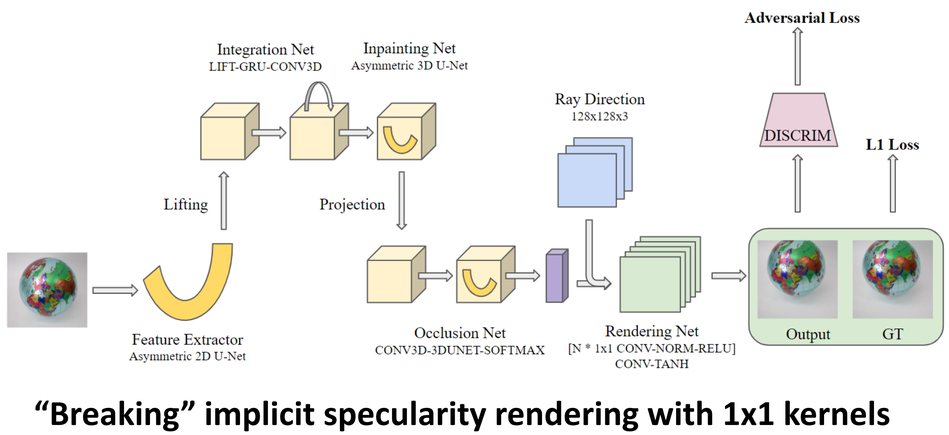
- Roughly 500 synthetic 2D renders of high quality 3D scans of non-specular objects and 400 real world captures of specular objects are used for training.
- Each training element consists of RGB renders of an object coupled with extrinsic and intrinsic camera parameters (e.g. pose).

Non-Specular

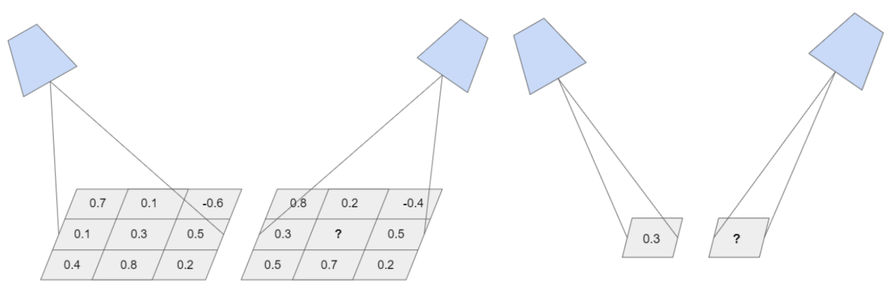
Specular

Model

New Specularity-Rendering Architecture



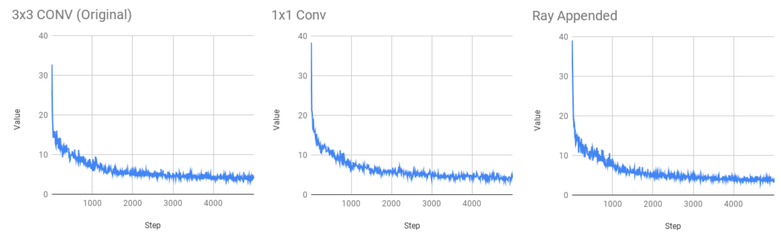
"Breaking" implicit specularity rendering with 1x1 kernels



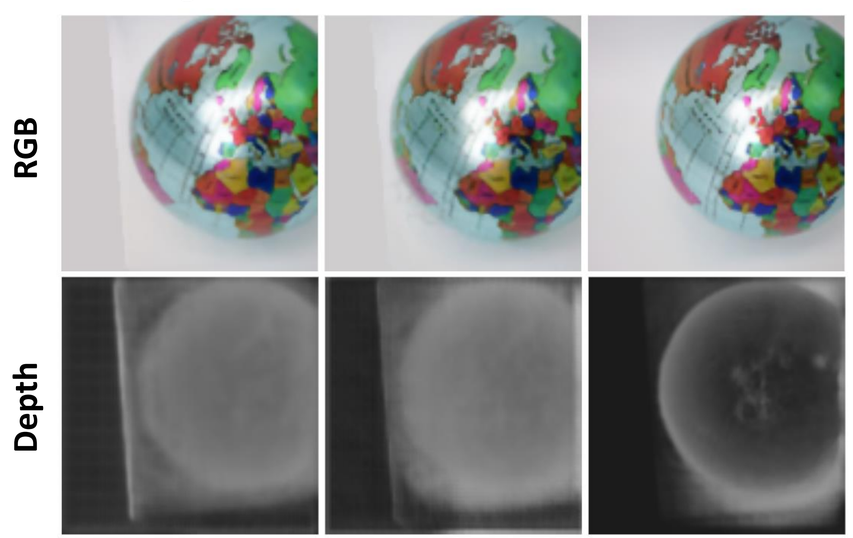
Results

- 1x1 CONV-based model has worse performance, but ultimately fails to break specularities.
- Augmented explicit ray-calculating model beats DeepVoxels by nontrivial margin on specular objects, has comparable performance on standard DeepVoxels.
- Depth maps reveal shortcomings of traditional DeepVoxels on specular objects (i.e. most real-captures). Treats specularities as part of voxel grid.

Weighted L1 & Adversarial Loss



SSIM/PSNR[1]	Original DeepVoxels	1x1 CONV Model	New Explicit Model
Non-Specular	0.96/27.99	0.93/25.11	0.94/26.44
Specular	0.86/25.18	0.84/24.53	**0.93/28.91**



References

[1] A. Hor and D. Ziou. Image quality metrics: Psnr vs. ssim. pages 2366–2369, 08 2010.
[2] V. Sitzmann. Deepvoxels. https://github.com/vsitzmann/deepvoxels, 2019.
[3] V. Sitzmann, J. Thies, F. Heide, M. Nießner, G. Wetzstein, and M. Zollhöfer. Deepvoxels: Learning persistent 3d feature embeddings, 2019.

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