Neural Radiance Fields (NERF) for Novel View Synthesis

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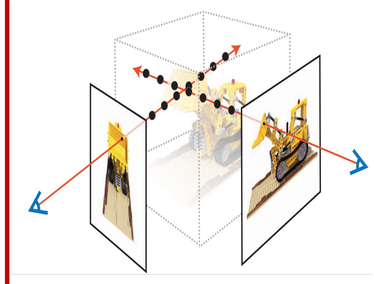
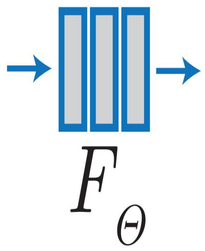
Motivation

View Synthesis: Sparse Photos → Continuous Representation of Visual Scene



Photos Taken from Known Position & Direction

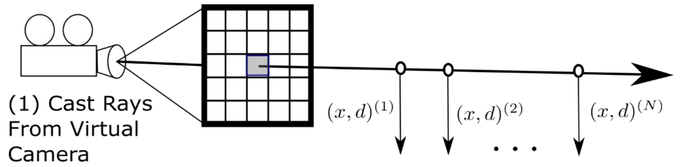


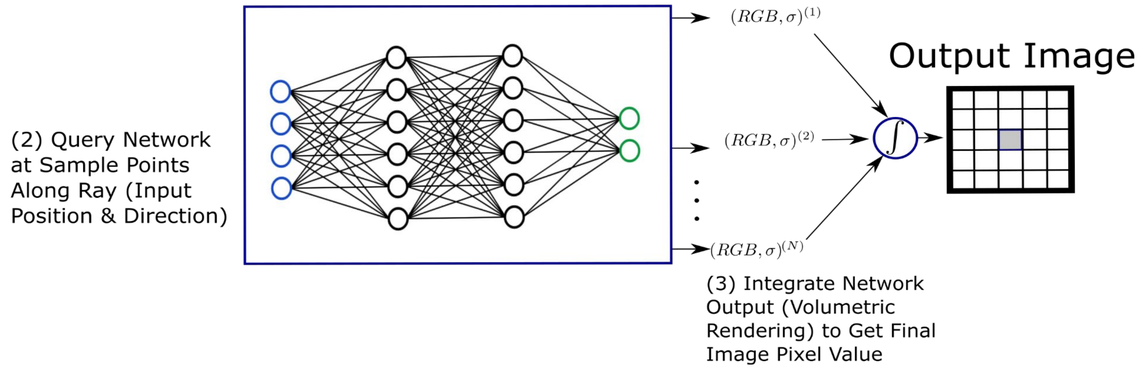
Learn a Dense Representation from sparse input

Synthesize Novel View by Querying Learned Representation

NERF

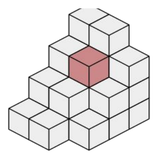
- Key Idea: Neural Network + Volumetric Rendering
  - Query NN to get Volumetric Density and Color
  - Use Rendering Techniques to get Output Image
  - Train Output to Match Ground Truth Images





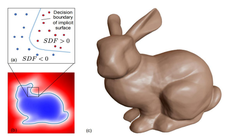
Related Work

- Classic Approach: Voxel Grid Representation of 3D Scenes
  - Extremely Inefficient (Poor Resolution Scaling)



Voxel Grids: Sample Color & Density along 3D-grid.

- More Recently: Deep Networks for Implicit Representation
  - Lackluster Performance, Over-smoothed Geometry



Deep networks: Learn Implicit Object Representation

References

[1] Seitz, S. M., & Dyer, C. R. (1999). Photorealistic scene reconstruction by voxel coloring. International Journal of Computer Vision, 35(2), 151-173.
[2] Park, J. J., Florence, P., Straub, J., Newcombe, R., & Lovegrove, S. (2019). Deepsdf: Learning continuous signed distance functions for shape representation. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 165-174). r
[3] Mildenhall, B., Srinivasan, P. P., Tancik, M., Barron, J. T., Ramamoorthi, R., & Ng, R. (2020, August). Nerf: Representing scenes as neural radiance fields for view synthesis. In European conference on computer vision (pp. 405-421). Springer, Cham.

Experimental Results

- *Test-Image PSNR vs Distance from Nearest Train Image*
  - Compare Test-Image with Network Output (PSNR)
  - Compute Euclidean Between Camera Locations:
  - normalize to [0,1], stack to create parameter vector
  - plot PSNR of network output (w.r.t. ground truth) vs Euclidean distance between test and nearest train parameter vectors
- Weak Negative Correlation between distance to nearest train image, and PSNR of test image.