HPA TECH RETREAT 2024

NeRFs and 3D Radiance Fields

The next generation of 3D asset creation

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Methods for creating 3D photorealistic scenes

- Graphic primitives and illustration
  - Painting and importing textures & normal maps
- Advanced creation tools
  - Landscape Sculpting
  - Foliage tools in Unreal
- Acquire assets from online store
- -or- use Photogrammetry

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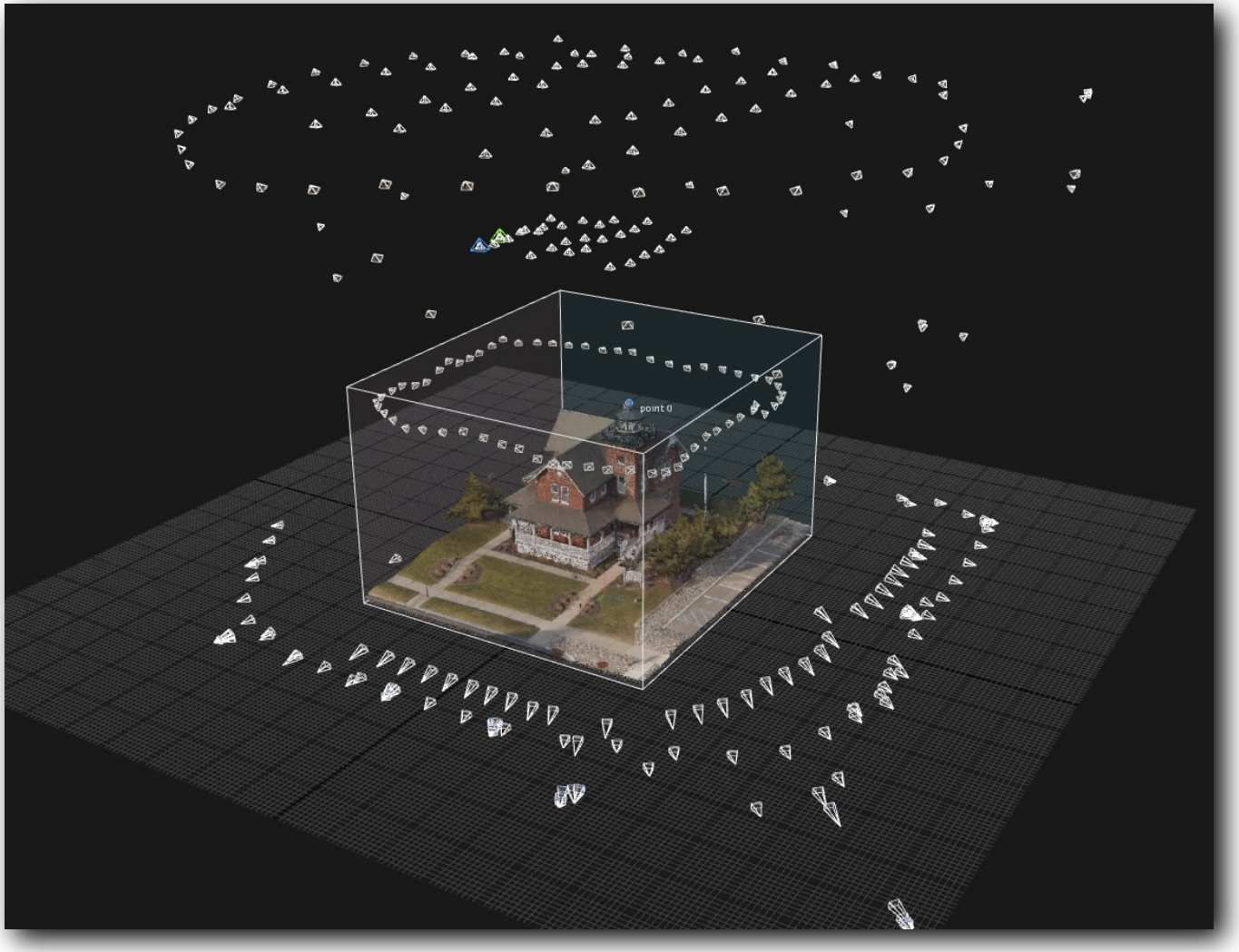
- -or- use Photogrammetry .. And now NeRFs & Splats

Photogrammetry

- Camera views



NeRF Explosion

- NeRF Explosion
  - Mildenhall et al 2020
  - 120 accepted papers at CVPR 2023
  - 51 papers at Siggraph 2023
  - Plus numerous at ECCV and Nvidea GTC

NeRFs Background - Mildenhall et al 2020

NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis

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NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis

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Abstract. We present a method that achieves state-of-the-art results for synthesizing novel views of complex scenes by optimizing an underlying continuous volumetric scene function using a sparse set of input views. Our algorithm represents a scene using a fully-connected (non-convolutional) deep network, whose input is a single continuous 5D coordinate (spatial location (x, y, z) and viewing direction (θ, ϕ)) and whose output is the volume density and view-dependent emitted radiance at that spatial location. We synthesize views by querying 5D coordinates along camera rays and use classic volume rendering techniques to project the output colors and densities into an image. Because volume rendering is naturally differentiable, the only input required to optimize our representation is a set of images with known camera poses. We describe how to effectively optimize neural radiance fields to render photorealistic novel views of scenes with complicated geometry and appearance, and demonstrate results that outperform prior work on neural rendering and view synthesis. View synthesis results are best viewed as videos, so we urge readers to view our supplementary video for convincing comparisons.

Keywords: scene representation, view synthesis, image-based rendering, volume rendering, 3D deep learning

1 Introduction

In this work, we address the long-standing problem of view synthesis in a new way by directly optimizing parameters of a continuous 5D scene representation to minimize the error of rendering a set of captured images.

We represent a static scene as a continuous 5D function that outputs the radiance emitted in each direction (θ, ϕ) at each point (x, y, z) in space, and a density at each point which acts like a differential opacity controlling how much radiance is accumulated by a ray passing through (x, y, z). Our method optimizes a deep fully-connected neural network without any convolutional layers (often referred to as a multilayer perceptron or MLP) to represent this function by regressing from a single 5D coordinate (x, y, z, θ, ϕ) to a single volume density and view-dependent RGB color. To render this *neural radiance field* (NeRF)

⋆ Authors contributed equally to this work.

arXiv:2003.08934v2 [cs.CV] 3 Aug 2020

Why are they unique?

- Uses Machine Learning
  - Fully connected Neural Network
  - In a non-traditional way
- Utilizes a new method of representing images
  - The Neural Network contains the image information
  - As a 5D Radiance Field

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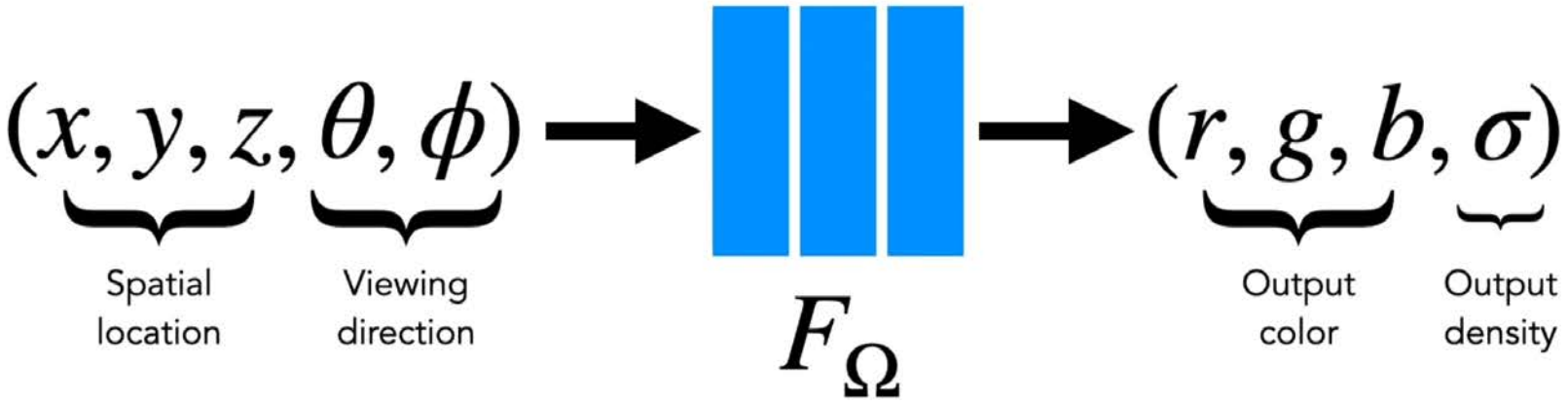
Maths

Representing a scene as a continuous 5D function



Input:
Location with viewing angle (Theta, Phi)
(ex: source photo)

Output:
Values for that point of observation/rendering

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- NeRF can capture scene parts further away from the center of focus
- Photogrammetry's ability to create depth info falls off with distance

It is just the beginning - buckle-up

- **This is a snapshot … things are changing rapidly**

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  - **This technology is just the engine for a whole new body of Generative Technology for 3D**

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- This is a snapshot … things are changing rapidly
- Making 3D photorealistic models is going to get easier
- Combining Radiance fields with generative technology is happening and will be even more of an accelerator
  - **This technology is just the engine for a whole new body of Generative Technology for 3D**
- **Multi-industry interest and investment**

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