Real-time Visualization and Guidance for Neural Radiance Fields.

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

In this project we want to implement a visualization and analysis framework for object-based Neural Radiance Fields (NeRF) [1] that guides live capture of data, visualizes camera poses of sequences, and detects missing view angles in a virtual dome. Our pipeline can provide a relative impression of the final reconstruction quality by the number of patches it covers in the visualization dome/hemisphere.

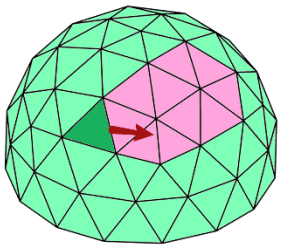

Figure 1 a virtual dome visualization, representing current and past traversed capturing angles and guidance to missing angles.

Background and Motivation

NeRFs are an emerging field of research that enable high-quality 3D reconstructions of real-world scenes from 2D images [1]. However, current approaches often suffer from incomplete data capture and reconstruction artifacts. Therefore, it is crucial to develop a framework that visualizes camera poses and detects missing view angles. Our framework aims to address these challenges and improve the quality of NeRF-based reconstructions.

This software has various potential use cases, including virtual and augmented reality, autonomous systems, and 3D content creation. For example, in virtual and augmented reality, our pipeline can improve the quality of 3D reconstructions of real-world scenes, enabling more realistic and immersive experiences. In autonomous systems, the framework can be used for obstacle detection and avoidance. Finally, in 3D content creation, our framework can provide a more efficient and accurate way to create 3D models from real-world scenes.

Several related works exist in the area of 3D reconstruction, including structure-from-motion (SfM) [3] and multi-view stereo (MVS) techniques [4]. However, these methods often suffer from incomplete data capture and reconstruction artifacts. Our proposed framework helps capture complete viewpoints by providing live camera pose trajectory and detecting missing view angle for reconstruction [1][2].

Student's Tasks Description

Our proposed framework consists of several tasks, including data capture, pose visualization in a virtual dome, missing view angle detection and guidance, and reconstruction quality estimation. Data capture involves capturing 2D images of the scene and converting them into NeRF reconstruction. Pose visualization enables observe camera poses and detect missing angles. The

visualization identifies missing angles in the hemisphere and optimizes camera positions for complete coverage. Finally, the framework estimates the reconstruction quality based on the number and distribution of patches covered in the hemisphere.

Technical Prerequisites

Recommended:

Strong understanding of computer vision and deep learning algorithms and PyTorch

Proficiency in Python programming language

Familiarity with 3D geometry and coordinate systems

Knowledge of 3D reconstruction techniques and neural radiance fields

Optional:

Experience with computer graphics and visualization frameworks (such as OpenGL, Unity, or Three.js)

Familiarity with 3D scanning technologies and data acquisition methods

Experience with cloud computing and distributed systems

Familiarity with Linux operating system and shell scripting

References

[1] Mildenhall, B., Srinivasan, P. P., Tancik, M., Barron, J. T., Ramamoorthi, R., & Ng, R. (2021). Nerf: Representing scenes as neural radiance fields for view synthesis. Communications of the ACM, 65(1), 99-106.

[2] Müller, T., Evans, A., Schied, C., & Keller, A. (2022). Instant neural graphics primitives with a multiresolution hash encoding. ACM Transactions on Graphics (ToG), 41(4), 1-15.

[3] Schonberger, J. L., & Frahm, J. M. (2016). Structure-from-motion revisited. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 4104-4113).

[4] Furukawa, Y., et al. "Accurate, dense, and robust multi-view stereopsis." IEEE Transactions on Pattern Analysis and Machine Intelligence 32.8 (2010): 1362-1376.