

Dynamic NeRF for real world driving scenarios

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Abstract

Autonomous driving (AD) presents a significant technological advancement in transportation, offering the potential for increased safety and efficiency. However, the development of reliable AD systems demands vast, diverse datasets collected from real-world environments. This poses significant challenges due to high costs, privacy concerns, and the difficulty of capturing rare but critical "corner cases" like sudden pedestrian crossings or adverse weather conditions. These scenarios are essential for training AD systems to handle complex real-world situations but are often missing in real-world datasets. Recent advancements in Neural Radiance Fields (NeRF) offer a compelling alternative for addressing these limitations, enabling the generation of photorealistic 3D scenes from limited number of overlapping images. While dynamic NeRF models extend the original NeRF's static scene framework to handle moving objects, they continue to exhibit challenges such as artifacts, lack of fine geometric detail, and limited scene editability—all essential for accurately simulating dynamic AD scenarios. Furthermore, existing NeRF-based models rely on complex architectures involving multiple deep neural networks (DNNs) and/or multilayer perceptrons (MLPs) to distinguish dynamic elements from static backgrounds, which increases complexity and often compromises performance, particularly for scenes involving objects at varying scales. The thesis explores K-Planes as a simplified yet powerful alternative to traditional dynamic NeRF models. By factorizing 4D dynamic scenes into 2D planes, K-Planes reduces architectural complexity while maintaining higher performance metrics. This method eliminates the need for intricate MLPs and segmentation methods, enabling multiscale plane representation that effectively reconstructs objects at various resolutions. As a result, K-Planes enhances geometric precision and accuracy, making it adaptable for AD simulations. The effectiveness of K-Planes was demonstrated through experiments on both static and dynamic datasets, including the Lego static, Lego dynamic, and Jumping Jacks datasets. The evaluation metrics show that K-Planes achieve results comparable to existing dynamic NeRF models but with improved efficiency in dynamic scene rendering. These results indicate that K-Planes can bridge the gap between simulated and real-world data, providing a scalable and practical solution for generating synthetic driving environments. The results of this research suggest that K-Planes is not only capable of producing accurate 3D scene reconstructions but also presents a viable alternative to complex NeRF-based dynamic models for autonomous driving simulations.

Keywords Autonomous driving, Neural Radiance Fields, K-Planes, 3D reconstruction, dynamic scenes, synthetic data generation