ETH
Eidgenössische Technische Hochschule Zürich
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CRL
Computational Robotics Lab

Semester Project or Master Thesis

GaussGNN: A Graph-Network Approach for Physics-based Deformations of Neural Radiance Fields

Figure 1: Two neural radiance fields (NeRFs) represented as collections of Gaussians (Images from Xie et al., *PhysGaussian: Physics-Integrated 3D Gaussians for Generative Dynamics.* Arxiv, 2023). The goal of this project is to develop a simulation method for this scene representation using Graph Neural Networks (GNNs).

Introduction

Neural radiance fields have shown remarkable capabilities in generating high-quality, realistic 3D scenes from 2D images. However, the static nature of these representations limits their applicability in scenarios where dynamic changes or deformations are essential. This project addresses this limitation by introducing a simulation-based approach to deform neural radiance fields represented as a collection of Gaussians. Gaussian splatting has recently emerged as a promising, computationally efficient alternative for representing and rendering neural radiance fields. The main idea of this project is to leverage this new representation for physics-based simulation. In particular, we aim to use Graph Neural Networks for learning the physics of collections of Gaussians using the Oriented Particles [Müller and Chentanez, 2011] as a basis.

Objectives

The primary objectives of this project are as follows:

1. Develop a simulation model for collections of Gaussian based on oriented particles [Müller and Chentanez, 2011].
2. Use Graph Neural Networks (GNNs) to learn the dynamics of oriented particles.
3. Develop a method for coarsening a given high-resolution collection of Gaussians into a hierarchical representation.
4. Develop algorithms to infer simulation connectivity among Gaussians across levels of the hierarchy.
5. Extend the GNN for hierarchical simulation.
6. Evaluate the performance and visual quality of the proposed on a diverse set of neural radiance fields.

Skills

- Experience in computer graphics, computer vision, and machine learning
- Familiarity with Neural Radiance Fields
- Experience with numerical simulation and/or optimization
- Very good programming skills in C++

Remarks

This thesis is overseen by Prof. Dr. Stelian Coros and is supervised by Dr. Bernhard Thomaszewski.

Contact

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