KI DELTA LEARNING
Scalable AI for Automated Driving

3D Reconstruction of Real-World Scenes

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WP 1.3

Environment

Use-Case in Delta Learning

Synthetic data samples are a promising approach to reduce the effort and costs, that are associated with the elicitation of annotated data samples. But in order to further reduce the needed amount of real data for training an AI model, the domain gap between the real and synthetic world has to be reduced.
This problem can be approached in various ways, e.g. using image-to-image translation or style transfer approaches that modify synthetic images to look more realistic. Another solution would be to enhance the content inside of the simulation, so that the directly generated images already look more realistic.

Technical Problem

In our work, we investigate how to automate the process of reconstructing real world scenes or scenarios for simulations. Even if those reconstructions are not perfect, they could act as a starting point for manual adjustments, reducing the overall manual effort. Currently, there is no fully integrated approach to reconstruct 3D scenes in the automotive setting and this gap shall be targeted in our work. The goal is to derive a 3D geometry representation based on images and sparse point clouds, gathered from sensors attached to a vehicle.
Secondly, in order to aim for realistic-looking simulations, an important part are the materials of objects in the scene. The materials describe the visual look of the object, e.g. color, specularity or translucency. Those properties shall also derived.

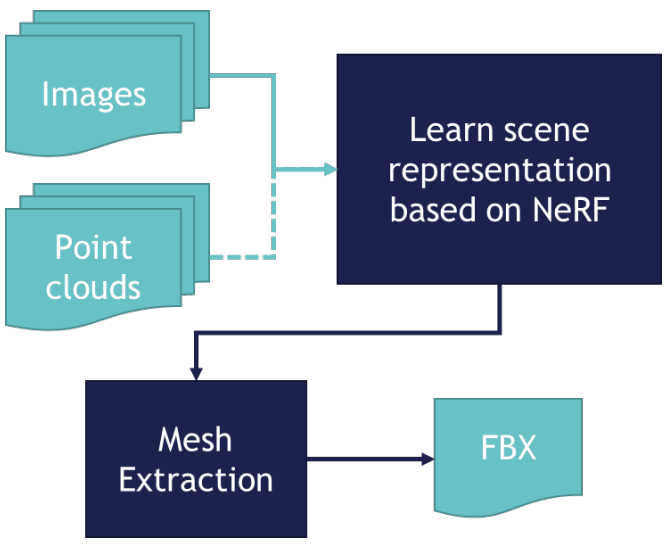

Figure 1: General scene reconstruction process based on Neural Radiance Fields

Technical Solution

Because of the already astonishing results that can be achieved with Neural Radiance Fields (NeRF), we base our work on this approach. When collecting data by driving around with a car equipped with various cameras and potentially also lidars, there will be a lot of transient occluders in the scene (other cars, pedestrians, ...). If the same scene is visited multiple times at different day times, the appearance will also vary between the recordings (e.g. lighting). Besides of that, street scenes tend to be quite large and full of details.
Because of those reasons, we developed an architecture that combines the ideas of different approaches like NeRF-W, NeRF++ and NSVF. After training this architecture on a set of images from a scene, the network will encode an internal representation of the scene in its weights. By sampling the network in a structured manner, an explicit simulator-ready representation can be extracted.

Evaluation

An evaluation of our approach can be performed on two levels:

1. The output of our NeRF-like architecture can be compared to the real images, so that the quality of the internal scene representation can be quantitatively measured.
2. The extracted mesh representation can be rendered from the same viewpoints of the real images, so that they can be compared. This comparison is of a rather qualitative nature, since the renderings heavily depend on the used renderer and the lighting of the scene.

In order to benchmark our approach, we developed a synthetic benchmark of renderings from street scenes using the CARLA simulator. This synthetic benchmark allows us to investigate the influence of other traffic participants, lighting situations or the used sensor setup on the quality of the reconstruction, resulting in hints for a real recording campaign.
The implementation of our full architecture is ongoing, but an evaluation of our intermediate implementation already shows quite satisfying results of learning an internal scene representation for a whole street scene.

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Partners

External partners

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KI FAMILIE

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