World Models for 3D Scenario Generation

Overview

World models have seen a spike of interest in recent years. Essentially, they are a generalization of the video reconstruction task, allowing for a generalizable prediction of how arbitrary environments evolve over time. The same world model may be able to predict how a bird flies, a car driver behaves and a lion jumps within a given time horizon.

With the advent of end-to-end learning in robotics, world models have seen an increased adoption, especially in autonomous driving [1, 2, 3, 4]. Here, two main pillars are the prediction of the current traffic scenario on board the vehicle, and the efficient simulation of traffic in order to train an onboard deep learning network. State-of-the-art examples include, e.g., the camera-based *GAIA-3* [5] and *GAIA-4* [6] from *Wayve*. The *Waymo World Model* [7] is specifically designed to produce consistent environments across different sensors, i.e., the generated camera and LiDAR output are congruent.

Figure 1: Example generated camera data using GAIA-4 [6, Fig. 1].

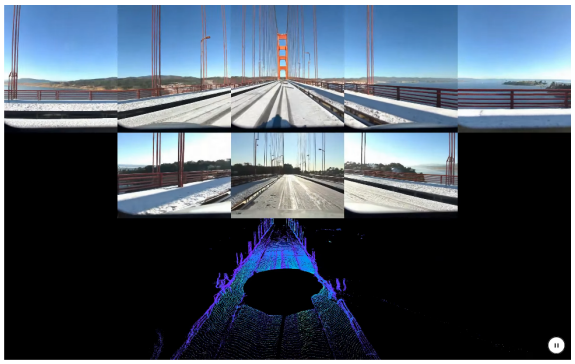

Figure 2: Example generated camera and LiDAR data using the Waymo World Model [7, Fig. 1].

Description

We are especially interested in the synthetic generation of traffic scenarios that can be used to train E2E models. World models usually have the disadvantage that the learned behavior might be visually consistent but unrealistic, especially across multiple traffic participants in the same scene, whereas classic approaches for testing motion planners usually use consistent, oftentimes recorded, traffic data. Our chair has developed the largest and most-used benchmark and software suite for motion planning, called CommonRoad [8]. However, our data mostly contains 2D trajectory scenarios. Now, we want to use world models to generate the synthetic camera and LiDAR data associated with these scenarios, so that our consistent scenarios can be used for vision-based E2E learning whilst still having the underlying 2D real-world data foundation.

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Research project:
CommonRoad

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Python

Required skills:
Experience in Deep Learning, Python

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English

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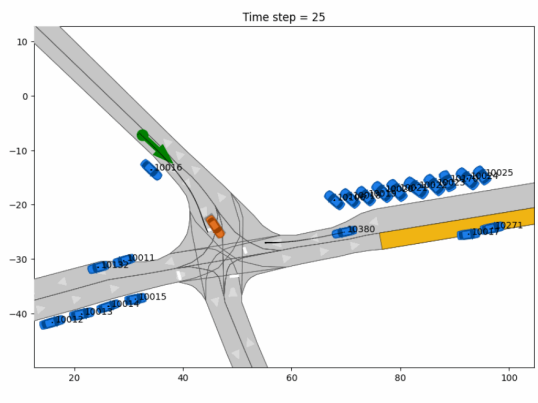

Figure 2: A real-world CommonRoad scenario from Germany.

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This thesis is the combination of a literature deep dive and practical work. The student should first research how world models work conceptually and, subsequently, what promising, state-of-the-art world models can be used as a starting point for our task. In the second phase, the student shall develop a world model for generating 3D synthetic environment data from 2D scenarios.

Tasks

- Familiarization with world models.
- Finding promising, state-of-the-art approaches that can be used as a starting point for development
- Developing the world model for the 3D synthetic data generation
- Evaluating the developed approach

Application

If you are interested in the topic, please send an email to the contact information provided on the right and attach a short **CV**, your current **grade report**, and your **Bachelor's grade report**.

Required skills are a good understanding of deep learning, good Python3 coding skills, practical knowledge of using Ubuntu, and an interest in applying novel learning algorithms and practical deep learning.

References

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