Vehicle Platooning Using Multi-Agent Reinforcement Learning

A Study on Autonomous Driving in the CARLA Simulator

Graduate

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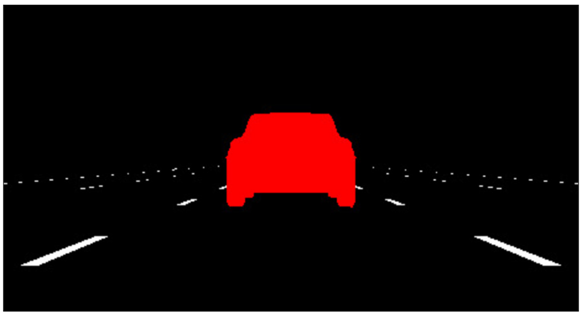
Introduction: The idea of autonomously driving vehicles has been around for many decades. While partial autonomy has been achieved, driverless vehicles on public roads emerged only in recent years, although in limited settings. In addition, the number of vehicles on public roads is steadily increasing, often leading to congested areas. One of the possibilities to improve the safety and to reduce congestion on public roads is platooning. In this setting, vehicles drive behind each other and form a moving queue. While platooning has been tested on highways, it mainly relies on control algorithmic approaches to mathematically model the world. In a complex traffic scenario often found in cities, not all real-life conditions can be modelled as a mathematical formula. A different approach is to use machine learning, specifically reinforcement learning, where an agent learns a task by repeating actions and receiving rewards depending on how good the outcome was.

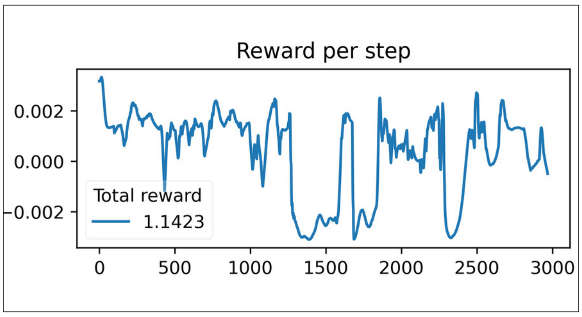
Objective: Training a model using reinforcement learning requires thousands of iterations to make any significant progress. A simulated 3D environment is best suited to repeatedly train and test such a model. This thesis uses a state-of-the-art 3D environment simulator for autonomous driving, suitably called CARLA (“Car Learning to Act”). It is an open-source simulator especially designed for research that provides realistic maps of towns, real world physics, various vehicle types, and simulation of real-world traffic scenarios. In this thesis, we investigate how to train a model that enables a car to drive in a platoon.

Result: We successfully trained a model using reinforcement learning that allows the follower to identify the leader vehicle and follow it in a previously unseen simulated environment. It can adapt its behavior depending on the leader vehicle’s actions, such as steering, slowing down and accelerating. It can operate in a multi-lane scenario and even manages to cross intersections. Building on this initial success, extensions such as obstacle avoidance, speed sign recognition, heavy traffic situations or a transfer to a real car can be further explored.

How the follower perceives the leader car through its camera.
Own presentment



An example of the positive and negative rewards received by the follower car in a vehicle platooning scenario.
Own presentment



Vehicle platooning situation in the CARLA simulator with the leader and follower car.
Own presentment

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Subject Area
Miscellaneous