Hybrid Parallel Online POMDP Decision Making for Lane Changes in Urban Areas

Background

As the "brain" of autonomous vehicles, the capabilities of behavior decision-making are decisive for enabling safe and socially acceptable autonomous driving in all traffic scenarios. Improving the intelligence of behavioral decision-making systems is one of the core challenges for autonomous driving. The challenges of making safe decisions include observing traffic rules and reasonably interacting with other traffic participants. Furthermore, the different uncertainties of perceived traffic information such as limited sensor measurements, uncertain motion and intention prediction, and occluded objects in complex urban areas need to be handled reasonably. Although state-of-the-art autonomous driving works well under sound conditions, dealing with these problems remains nontrivial.

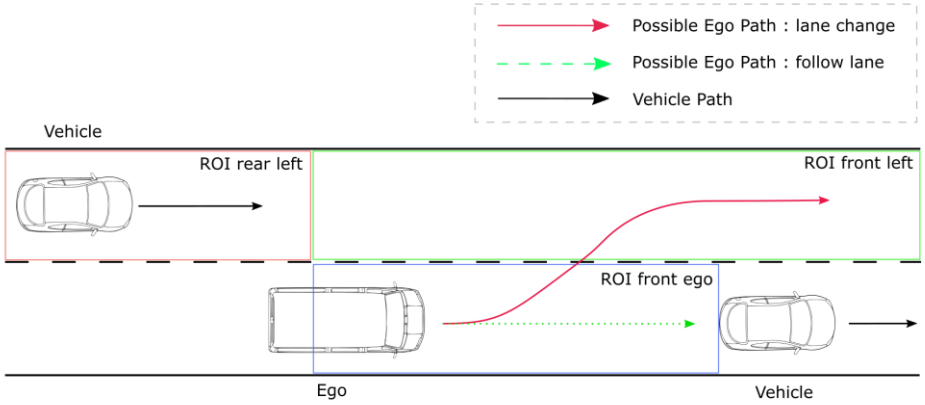

Figure 1: Typical scenario for lane change decision making with two dynamic objects and three regions of interest rear left, front left and front ego

Motivation

Deciding and executing maneuvers like lane changes in automated vehicles without any human interaction is a challenging and essential step towards fully autonomous driving. Previous research into Partially Observable Markov Decision Process (POMDP) demonstrated its potential in solving decision-making problems.

This master thesis should investigate the application of POMDP in lane changing decision-making, which involves planning a sequence of actions in an uncertain environment, considering all constraints on longitudinal and lateral direction delivered by other components in our architecture.

Furthermore, the performance of POMDP planning algorithms is also dependent on the solver itself. State of the art online solvers rely on the Monte Carlo tree search method. Currently, POMDP solvers that enable multiple threads and the GPU parallelization mechanism have been published and have shown performance improving. In this thesis, state of art Parallelized POMDP solver should also be investigated.

Tasks

- Literature research for state of the art algorithm and POMDP relevant methods for lane changing maneuver
- Concept development for lane changing maneuver using POMDP framework
- Investigate and apply parallelized POMDP solver
- Implement the algorithm and integrate in current architecture
- Test the algorithm in the simulation environment

Requirements

- Solid programming skills in C++
- Good knowledge of Python, ROS
- Knowledge of Markov Decision Process will be beneficial
- Able to work independently

Application and Contact

This thesis is an external master thesis in cooperation with ZF Friedrichshafen AG. The working location is in Friedrichshafen. If you are interested in this offered thesis topics and would like to gain practical experience in developing autonomous driving in an industrial environment, please send your Application Materials including (Resume, Motivation letter and Transcript of Records) to me.

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