Using dynamic priority assignment to increase feasibility in priority-based networked control

(Bachelor thesis)

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Motivation

This thesis is situated within the GROKO-Plan project which aims to research optimal graph-based trajectory planning for interacting vehicles.

When planning trajectories for non-cooperative vehicles, inconsistent solutions can arise when two vehicles periodically begin and stop to swerve in the same direction trying to avoid a collision. This can be mitigated by assigning priorities to the vehicles, specifying which one must evade.

Introducing priorities can lead to instances where low priority vehicles get wedged in between high priority ones in such a way that avoiding a collision becomes infeasible for the former. I want to examine how to update these priorities dynamically such that these situations do not arise.

State of the Art

First, there exist heuristics like the one proposed by Bennewitz et al. in 2002 which uses a central instance performing a hill climb search to determine which priority distribution would result in a more optimal trajectory. Feasibility is ensured by examining the resulting potential paths.

Second, there are dynamic distributed approaches which reprioritise at specific events like the addition of new vehicles to the network or in between larger planning sections. One approach on how the priorities can be determined is through a Future Collision Assessment (FCA) proposed by Luo et al. in 2016. It prioritises the vehicles that have more potential collisions on their future paths.

A modelling of the priority assignment as a minimum linear ordering problem (MLOP), in which the goal is to find a linear ordering such that the objective function is minimised, is also mentioned (Luo et al., 2016). There exists a greedy 4-approximation algorithm to the MLOP problem if the objective function is supermodular (Iwata et al., 2012).

Goal

The main goal of this thesis is to improve upon a distributed trajectory planner, which exists in the Cyber-Physical Mobility Lab, by upgrading it from a static priority assignment to a dynamic one, such that all 20 model-scale vehicles can be routed. Optionally I would like to examine if it is possible to guarantee feasibility without substantially increasing computational complexity by examining the aforementioned modelling as a MLOP.

Planned Approach

The initial step will be to come up with example situations in which the current static priorities lead to infeasible problems and implement a version of the described FCA inside the cyber-physical mobility lab. Next, I want to evaluate the new trajectory planner by comparing the dynamic version to one with randomly generated fixed priorities. Initially the vehicles will be restricted to a certain trajectory and only have variable acceleration.

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