# Master Thesis

## Parallel Priority-based Trajectory Planning with Safety Guarantees for Networked Vehicles

### Problem Statement

The project GROKO-Plan aims at developing a graph-based trajectory planning method for networked vehicles. Centralized trajectory planning is computationally intractable for many vehicles. The computation load can be reduced by sequential priority-based distributed trajectory planning, in which vehicles plan and communicate trajectories sequentially. An increasing number of coupled vehicles leads to an increasing number of computation levels, which limits the size of the networked control system (NCS). This limit can be surpassed by parallel computation of trajectories.

Parallelizing trajectory problem bears the problem of prediction inconsistency: a higher prioritized vehicle that communicated its planned trajectory might change it in the following timestep. Figure 1 illustrates the parallely planned trajectory of a lower prioritized yellow vehicle at time $t = k$, which is collision-free to the communicated trajectory of the blue vehicle at time $t = k - 1$. Figure 2 shows that if the blue vehicle changes its plan and turns left instead of going straight, the yellow vehicle is unable to avoid a collision.

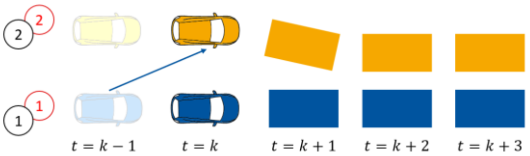


FIGURE 1 PREDICTED OWN TRAJECTORY (YELLOW) AND DELAYED, COMMUNICATED NEIGHBOUR'S TRAJECTORY (BLUE)

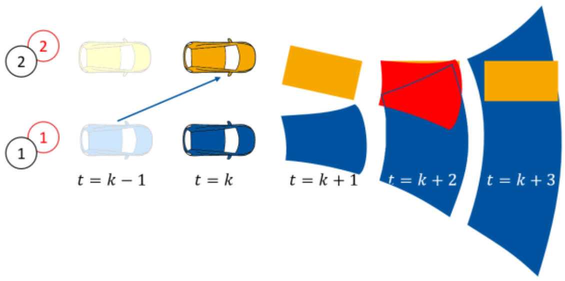


FIGURE 2 POSSIBLY UNSAFE TRAJECTORY PLAN DUE TO PREDICTION INCONSISTENCY.

### Task

- Create a time-variant coupling graph based on the reachable sets of agents
- Deal with prediction inconsistency between agents by reachability analysis to generate fail-safe trajectories [1] in parallel priority-based distributed model predictive control
- Find criteria to form groups of agents which should compute sequentially to improve solution quality while ensuring real-time capability
- Split and merge groups of sequentially computing agents

### Qualifications

- Knowledge of MATLAB and/or C++
- Affinity to mathematics
- Student of Automation Engineering, Computer Science, Mechanical Engineering or a similar study program

### Contact


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Please include in your application: transcript of records, CV and certificates.


[1] Pek, Christian, and Matthias Althoff. 2021. "Fail-Safe Motion Planning for Online Verification of Autonomous Vehicles Using Convex Optimization." IEEE Transactions on Robotics 37