Semester Project, Master Thesis

Plug-and-Play Distributed Multi-Trajectory Model Predictive Control: An Application to Autonomous Racing

Keywords: MPC, Plug-and-Play, Collaborative Systems, Robotics

Project description:

Consider a swarm of autonomous agents that can only communicate with spatially close neighbors with the goal of collaborating in order to reach their target destination and avoid collisions. In this scenario, it is important to consider agents that are outside of the communication radius but can inadvertently join the fleet and cause collisions. A possible solution to this problem is an automatic plug-and-play mechanism that does not require a negotiation stage as often proposed in the literature, see for example [1].

The objective of this project is to study distributed multi-trajectory MPC-based algorithms for controlling a swarm of autonomous agents in order to offer a plug-and-play mechanism which do not require negotiation and/or communication. The envisioned solution will extend a path-following model predictive contouring controller (MPCC) [2] with a multi-trajectory model [3]. After the successful implementation for a single agent, it will be extended to multiple agent with limited communication range. The controller will be tested on a figure-eight problem benchmark [4] first in simulation and then on hardware.

Your project would include

- A literature research on the current state of the art about multi-agent and multi-trajectory control
- Implementation of the state-of-the-art algorithms
- Development of a novel method for path-following and plug-and-play distributed MPC
- Simulation of the developed algorithm
- Test of the algorithm with RC cars

[1] M. Zeilinger et al, “Plug and play distributed model predictive control based on distributed invariance and optimization”


[4] Figure 8 racing, Wikipedia, https://en.wikipedia.org/wiki/Figure_8_racing

Prerequisites:

Strong background in control theory, MPC, and experience in Python and C++ are required.

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