Robotics and Embedded Systems

KI.FABRIK

Master/Bachelor Thesis – Semester Project

Algorithms for Multiple Dynamic/Static Obstacle Avoidance

Background

Research into obstacle avoidance for static and dynamic obstacles has garnered widespread attention in the fields of robotic manipulations and autonomous vehicles. A real-time control framework was proposed for optimal trajectories a real-time control framework that combines optimal trajectories generated through optimal control with the computationally efficient control barrier method providing safety guarantees [1]. The expert demonstration technique was combined with signal temporal logic (STL) and control barrier function (CBF) to maintain the safety specifications [2]-[3]. A deep reinforcement learning algorithm soft actor-critic (SAC) was developed for the path planning of robotic manipulators in the dynamic environment [4]. However, these mentioned algorithms cannot be well performed in multiple dynamic obstacle avoidance, particularly in scenarios where there is no prior information about these moving obstacles. Therefore, the optimization and real-time adaptation are exclusively reliant on the perceptions obtained during the control process.

Your Tasks

In this thesis, your jobs can be selected from the following tasks or your own ideas relative to this topic. To be specific:

1. Bachelor can read a substantial amount of literature in related fields and complete a review. (BA)
2. **Perception:** Design perception algorithms for mobile obstacles using data from cameras or LIDAR, in order to construct unsafe sets in real-time. (MA/BA)
3. **Control & planning:** The issue of feasible solutions under inequality constraints generated by the safe set of multiple obstacles in the context of optimal control or proposing relative path planning algorithms. (MA/BA)
4. **Leaning:** Designing evasion rules for dynamic obstacles based on reinforcement learning methods, subsequently yielding a reasonable and efficient reward function or designing expert demonstration algorithms. (MA/BA)

Requirement

- High self-motivation.
- Experiences or knowledge from related courses.
- C++ or Python programming experiences.

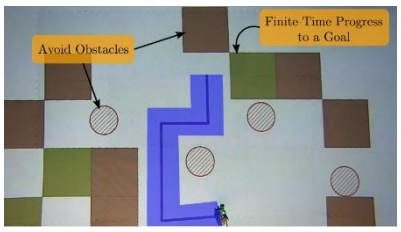

Figure 1. Multiple dynamic/static obstacle avoidance in the fields of robotic manipulations and autonomous vehicles.

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[3] Lindemann L, Robey A, Jiang L, et al. Learning robust output control barrier functions from safe expert demonstrations[J]. arXiv preprint arXiv:2111.09971, 2021.

[4] Chen P, Pei J, Lu W, et al. A deep reinforcement learning based method for real-time path planning and dynamic obstacle avoidance[J]. Neurocomputing, 2022, 497: 64-75.