

Perception-aware navigation for micro aerial vehicles in dynamic environments

MSc. Project Proposal at the Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft

Brief description: Autonomous navigation for micro aerial vehicles (MAVs) in dynamic uncertain environments is crucial for their deployment in real world applications. Due to limited size and computation capacity of MAVs, vision-based navigation is a promising solution in which onboard cameras are used for state estimation and obstacle detection [1]. The state estimation and obstacle detection results are then used to plan a safe trajectory for the MAV to navigate. However, in dynamic uncertain environments, the navigation safety may suffer from the state estimation and obstacle detection uncertainty [2], [3]. To this end, this project aims to develop a perception-aware approach for safe MAVs navigation while minimizing the perception uncertainty. Two connected projects are available:

- A) Onboard vision-based method for safe motion planning for MAVs in dynamic uncertain environments. The planner could be a model predictive controller which integrates collision avoidance, goal progressing, and perception quality within a receding horizon navigation framework.
- B) Perception and system integration for a quadrotor. You will implement the state estimation, obstacle detection for a quadrotor, as well as the developed perception-aware motion planning method. In this project good C++ and ROS skills are desirable.

You will test your approach in experiments with a quadrotor (Parrot Bebop 2) and onboard sensing and computing (RealSense D435i, Jetson TX2) at the DCSC Lab and the Cyberzoo at TUD.

Desired qualities:

- Motivated and independent
- Good problem solving skills
- Experience/interest in motion planning, optimization algorithms and/or autonomous navigation
- Experience in C++ programming and Robot Operating System (ROS)

For further questions or to apply, please contact H. Zhu <h.zhu@tudelft.nl> or Ass. Prof. Dr. J. Alonso-Mora <j.alonsomora@tudelft.nl>. When applying, please provide a short motivation, up to date CV, a transcript of your current degree program and intended start date.

Group information: <http://www.autonomousrobots.nl/>

References:

- [1] J. Lin, H. Zhu, and J. Alonso-Mora, "Robust vision-based obstacle avoidance for micro aerial vehicles in dynamic environments," submitted to *2020 IEEE International Conference on Robotics and Automation (ICRA)*.
- [2] Z. Zhang, and D. Scaramuzza, "Perception-aware Receding horizon navigation for mavs," in *2018 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2018, pp. 2534-2541.
- [3] D. Falanga, P. Foehn, P. Lu, and D. Scaramuzza, "PAMPC: perception-aware model predictive control for quadrotors," in *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2018, pp. 1-8.

