Risk-Aware Motion Planning for Multi-Robot Systems

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

Brief description: Autonomous robots are operating in complex environments sharing with other robots and moving obstacles for real world applications, where safe navigation becomes an essential challenge [1]. Typically, robots perceive the environments through sensors that have measurement noise and uncertainty [2]. In addition, each robot will have to anticipate the behavior of other robots for motion coordination which is also uncertain. To ensure safety of operating under those uncertainties, it is important to endow robots with the capability of assessing risk and making risk-aware decisions [3].

The objective of this thesis is to develop a risk-aware motion planning method for multi-robot systems in dynamic environments. Two connected projects are available:

A) Risk modeling and assessment. Given the environment information and anticipation of other robots' behaviors with uncertainty, a robot needs to reason about its neighboring environment and assess the risk of its motion plan.

B) Risk-aware motion planning and coordination. Incorporating the proposed risk model and assessment method with a local motion planner, e.g. a model predictive controller (MPC), to achieve safe navigation of multi-robot systems.

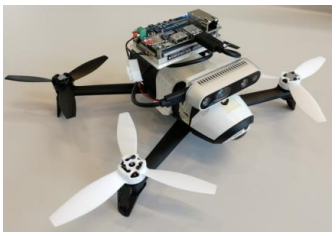
You will test your approach in experiments with multiple quadrotors (Crazyflie 2.1, Parrot Bebop 2) at the DCSC Lab and the Cyberzoo at TUD.

Desired qualities:

- Motivated and independent
- Good problem solving skills
- Experience/interest in motion planning, constrained optimization, MPC and/or probabilistic theory
- Experience in Python/C++ programming and Robot Operating System (ROS)

For further questions or to apply, please contact Mr. H. Zhu <h.zhu@tudelft.nl> and 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] H. Zhu, and J. Alonso-Mora, "Chance-constrained collision avoidance for mavs in dynamic environments," *IEEE Robotics and Automation Letters*, vol. 4, no. 2, pp. 776–783, 2019.

[2] A. Pierson, W. Schwarting, S. Karaman, and D. Rus, "Navigating congested environments with risk level sets," in *2018 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2018, pp. 1-8.

[3] A. Majumdar, and M. Pavone, "How should a robot assess risk? Towards an axiomatic theory of risk in robotics," *Robotics Research*, pp. 75-84. Springer, Cham, 2020.