Fast Collision Risk Estimation for Probabilistic Motion Planning

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

Brief description: Autonomous mobile robots are operating in complex environments for real world applications, where safe navigation and collision avoidance becomes an essential challenge [1]. Typically, the robots perceive the environments through sensors such as cameras. Uncertainty arising from the sensor noise makes safe navigation even more challenging. Hence, it is necessary to incorporate the uncertainty into robot motion planning, where the evaluation of trajectory collision probability plays an crucial role. Many works have been presented to compute the collision probability, including those analytic approaches [2] and the recently developed learning-based method [3]. However, they are limited to either static environments or single-robot scenarios. To this end, this project aims to develop a fast efficient approach to estimate the robot motion collision risk, and incorporate it into a motion planner to achieve probabilistic safe motion planning.

Two connected projects are available:

A) Estimating the collision risk of a robot motion plan. A potential methodology is to generate a dataset via Monte Carlo sampling and using it to train an estimator.

B) Incorporating the collision risk estimation method with a local motion planner, e.g. a model predictive controller, to achieve probabilistic collision avoidance in dynamic uncertain environments.

You will test your approach in experiments with a quadrotor (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, machine learning and/or autonomous navigation
- Experience in Matlab/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] 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. Blake, A. Bordallo, K. Brestnichki, and et. al. "FPR: Fast Path Risk Algorithm to Evaluate Collision Probability," *IEEE Robotics and Automation Letters*, vol. 5, no. 1, pp. 1-7, 2019.

[3] S. Dai, A. Hofmann, and B. C. Williams, "Fast-reactive probabilistic motion planning for high-dimensional robots", submitted to *The International Journal of Robotics Research*, 2019.