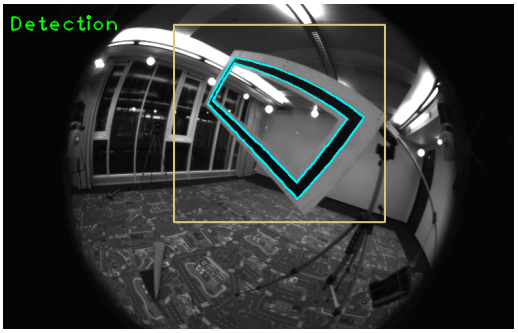
Visual-Servoing for an Under-Actuated Aerial Manipulator

Background

Aerial manipulators are aerial robots designed to manipulate objects and physically interact with the environment. In other words, they function as “flying hands” rather than simply “flying cameras.” An emerging application of aerial manipulators is to control the pose of an object for tasks such as pick-and-place and peg-in-hole. However, most existing work assumes that the poses of both the object and the aerial manipulator are already known, effectively bypassing the perception pipeline by relying on external motion-capture systems. This creates a significant gap from real-world operations, where only onboard perception is available.

In this project, you will explore visual servoing methods for aerial manipulation, developing a comprehensive perception pipeline for the flying robot. This pipeline will include visual-inertial odometry (using an off-the-shelf product) and object pose estimation. You will then combine the perception pipeline with contact-based control and planning algorithms, enabling a full-stack evaluation in real-world experiments.



Research questions

- How to develop onboard perception methods to achieve pose estimation for the object to be manipulated?
- How to enable autonomous flight of aerial manipulators without relying on an external motion-capture system?
- How to conduct visual servoing using the developed perception pipeline in combination with contact-based control and planning algorithms?

What we expect from you:

- Highly motivated.
- Experience in programming languages such as Python and C++.
- Experience with robotic perception is a bonus.
- Experience with real-world experiments with drones is a bonus.

What you can learn from this project:

- Hands-on experience with the perception and control of multi-UAV (aerial robot) systems.

- Access to our optimization-based control framework of drone systems in C++, ROS, and Docker.
- Hands-on experience in hardware development of aerial robots.
- Chance to publish in high-ranking robotic and ML conferences/journals.

Reference

[1] Ramon-Soria, Pablo, Begoña C. Arrue, and Anibal Ollero. "Grasp planning and visual servoing for an outdoors aerial dual manipulator." *Engineering* 6.1 (2020): 77-88.

[2] Ollero, Anibal, et al. "Past, present, and future of aerial robotic manipulators." *IEEE Transactions on Robotics* 38.1 (2021): 626-645

[3]Chen, Yanjie, et al. "Image-based visual servoing of unmanned aerial manipulators for tracking and grasping a moving target." *IEEE Transactions on Industrial Informatics* 19.8 (2022): 8889-8899.

Contact:

If you are interested in conducting this cool project, please contact Dr. Sihao Sun via

s.sun-2@tudelft.nl

When applying, please provide a short motivation, an up-to-date CV, a transcript of your current degree program, and an intended start date.

Short bio of the supervisor:
Dr. Sihao Sun is a new member of CoR funded by the NWO talent program “Veni” grant. He has extensive experience in the control, planning, estimation, and machine learning of aerial robotic systems by working with Prof. Davide Scaramuzza, Prof. Antonio Franchi, and Prof. Guido de Croon. He’s the winner of the Best Paper Award of Robotics and Automation Letters (RAL) and the NASA Tech Brief award. He has supervised over 20 MSc students, and three of them won CumLaude respectively in TU Delft and ETH / Zurich.