

## Topic

Drone wind estimation and control.

## Supervision and contact information

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## Teaser

Do you want to be part of research towards better performing drone controllers to make them more suitable for real-world applications? During this project, you will develop an estimation and control algorithm for a drone flying in an environment with varying wind flows.

## What will you be doing?

*Problem definition:* drones are becoming increasingly important in our society. They are used for different purposes, including, but certainly not limited to, search and rescue, packet delivery and entertainment. Reliability is an important aspect to consider for these real-world applications: drone controllers should be able to safely track trajectories in the presence of unanticipated wind disturbances.

*Objective:* the main project goal is to design, implement and test a wind estimation and control algorithm on a real drone. The estimation algorithm should provide accurate estimates of the effect of varying wind conditions on the drone movement. The controller uses the estimates to calculate a suitable control action to alleviate the effect of wind on drone stability and flight performance.

### Main activities:

1. Literature study (~3 months):
  - Obtain overview of state-of-the-art wind estimation methods
  - Obtain overview of state-of-the-art control approaches to accommodate for time-varying wind disturbances
  - Formulate the research question for the thesis project
2. Thesis project (~6-9 months):
  - Design and implement a wind estimator and controller:
    - Implement a baseline approach
    - Design a suitable wind estimation method, based on results of the literature study
    - Design a suitable robust controller, based on results of the literature study
    - Define testing scenarios to evaluate and compare the proposed estimator and controller
  - Test the combination of estimator and controller:
    - Perform tests in simulation
    - Perform tests in the lab

## What do we require from you?

- Background in topics of the following and related courses:
  - Dynamics and control
  - Model predictive control
  - Planning & decision making
  - Robot software practicals
- Experience with Python, C++, MATLAB, ROS or similar software is preferred
- Good communication in English
- A creative and pro-active attitude

## Related literature

Some potentially interesting literature to consider includes: [1], [2], [3], [4], [5] and [6].

## References

- [1] Lei Zheng et al. “Safe Learning-based Tracking Control for Quadrotors under Wind Disturbances”. In: *arXiv preprint arXiv:2009.01992* (2020).
- [2] Longhao Qian and Hugh HT Liu. “Path-following control of a quadrotor UAV with a cable-suspended payload under wind disturbances”. In: *IEEE Transactions on Industrial Electronics* 67.3 (2019), pp. 2021–2029.
- [3] Fabrizio Schiano et al. “Towards estimation and correction of wind effects on a quadrotor UAV”. In: *IMAV 2014: International Micro Air Vehicle Conference and Competition 2014*. International Micro Air Vehicle Conference and Competition 2014 (IMAV 2014). 2014, pp. 134–141.
- [4] Juan Escareño et al. “Trajectory control of a quadrotor subject to 2D wind disturbances”. In: *Journal of Intelligent & Robotic Systems* 70.1 (2013), pp. 51–63.
- [5] Steven Waslander and Carlos Wang. “Wind disturbance estimation and rejection for quadrotor position control”. In: *AIAA Infotech@ Aerospace conference and AIAA unmanned... Unlimited conference*. 2009, p. 1983.
- [6] Christopher V Rao. *Moving horizon strategies for the constrained monitoring and control of nonlinear discrete-time systems*. The University of Wisconsin-Madison, 2000.