UAV path planning for maximum-information sensing in spatiotemporal data acquisition

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Project description:
When observing data on the ground using a camera or similar sensor from a fixed-wing unmanned aerial vehicle (UAV), the variations in attitude of the vehicle has a significant impact on the quality of the acquired data. Disturbances in attitude caused by turbulent winds, and the changes in course and possibly altitude, can make the ground features of interest unstable in the sequence of images, or even appear outside the image frames.

A common solution to this problem is to employ a gimbal that decouples the UAV attitude from the camera attitude by actively controlling the camera attitude towards objects of interest using inertial sensors. The additional weight and space requirements of a gimbal has severe consequences on the UAV payload design, so it is of interest to study how this problem can be solved by control of the UAV itself when the camera is assumed to be fixed to the UAV airframe. This project will investigate some alternative flight control algorithms with the purpose of optimizing hyperspectral image acquisition quality.

The following items should be considered:

1. Conduct a literature review on algorithms for fixed-wing UAV flight control for optimal ground observation.
2. Develop a kinematic model of the UAV and camera system that allows a point on the ground (assume flat earth, e.g. at sea) to be optimally mapped to UAV position and attitude, and inversely.
3. Develop a trajectory planning algorithm for the optimal trajectory given a desired ground trajectory for the camera center point, i.e. shift the UAV position to observe ground points that account for necessary pitch and roll motions required to change course and altitude.
4. Implement the algorithm in DUNE and test using software-in-the-loop simulation and flight tests.

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