Optical and Radio Tracking of Aircraft to Measure Atmospheric Wind Profiles and Turbulence

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What can you learn about the atmosphere by watching aircraft fly? A lot: The Met Office’s most important source of wind data by far comes from aircraft that report their GPS position, ground velocity, and air velocity using radio broadcasts. Just subtract the air velocity from the ground velocity to find the wind velocity!

In this project we will investigate the additional opportunities for measuring wind that arise when planes come in to land at airports, probing the very important "planetary boundary layer" near the Earth's surface where strong wind gradients and turbulence are present. Near ground, we can get video footage of the planes, in addition to decoding the position and velocity from their radio broadcasts. Here are video footage examples: https://www.youtube.com/watch?v=FAGtkcsvR-w, https://www.youtube.com/watch?v=pfw5Om1zLBIA

We will apply pattern-recognition and object-tracking software (python openCV) to video camera footage from airport webcams (in a wide range of weather conditions) as well as our own video camera footage obtained at Exeter airport. When planes land in strong winds, they appear to fly sideways -- they orient themselves to face the wind in what is known as a "crab landing". By tracking the plane’s "crab" motion, we can measure the wind speed and direction as a function of altitude. Additionally, by tracking the fluctuations in the plane’s orientation we aim to measure turbulence.

The project supervisors are Chris Brunt (Astrophysics, Exeter) and Malcolm Kitchen (Observations R&D, Met Office). This is mainly a computing project, but includes some field work observations of planes landing at Exeter or Bristol airport (Covid circumstances dependent). It would suit a computer science student or an engineering student with strong computing (python) skills. For remote working, a laptop or PC is required. The student will gain experience in the interlinked computing, engineering, physical, and meteorological aspects of this research.
Timescale

This is a proposed 10 week project. An indicative timescale is given below, with some flexibility to account for the student's interests and external factors:

- Weeks 1-2: To gain initial experience, we will start by applying our existing tracking software to archive camera footage of aircraft landing at airports.
- Weeks 3-4: Based on the interests and experience of the student, the project could subsequently focus on code development or on engineering aspects (e.g. camera optimisation) - or on some combination of these. Field work (Covid regulations permitting.)
- Weeks 5-7: Testing and analysis of the improved code and/or camera. Detailed analysis of data to extract physical and meteorological information.
- Weeks 8-10: Finalising results and documentation of the work. We expect that there will be an opportunity for the student to present their work to an audience of Exeter and Met Office staff.