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UAV multirotor platform for accurate turbulence measurements in the atmosphere

Fernando Carbajo Fuertes, Lionel Wilhelm, Kevin Edgar Sin, Matthias Hofer, and Fernando Porté-Agel
École Polytechnique Fédérale de Lausanne, ENAC, WIRE, Lausanne, Switzerland (fernando.carbajo@epfl.ch)

One of the most challenging tasks in atmospheric field studies for wind energy is to obtain accurate turbulence measurements at any location inside the region of interest for a wind farm study. This volume would ideally include from several hundred meters to several kilometers around it and from ground height to the top of the boundary layer.

An array of meteorological masts equipped with several sonic anemometers to cover all points of interest would be the best in terms of accuracy and data availability, but it is an obviously unfeasible solution. On the other hand, the evolution of wind LiDAR technology allows to measure at any point in space but unfortunately it involves two important limitations: the first one is the relatively low spatial and temporal resolution when compared to a sonic anemometer and the second one is the fact that the measurements are limited to the velocity component parallel to the laser beam (radial velocity).

To overcome the aforementioned drawbacks, a UAV multirotor platform has been developed. It is based on a state-of-the-art octocopter with enough payload to carry laboratory-grade instruments for the measurement of time-resolved atmospheric pressure, three-component velocity vector and temperature; and enough autonomy to fly from 10 to 20 minutes, which is a standard averaging time in most atmospheric measurement applications. The UAV uses a gyroscope, an accelerometer, a GPS and an algorithm has been developed and integrated for the correction of any orientation and movement. This UAV platform opens many possibilities for the study of features that have been almost exclusively studied until now in wind tunnel such as wind turbine blade tip vortex characteristics, near-wake to far-wake transition, momentum entrainment from the higher part of the boundary layer in wind farms, etc.

The validation of this new measurement technique has been performed against sonic anemometry in terms of wind speed and temperature time series as well as the most important turbulence statistics such as turbulence intensity or momentum and heat turbulent fluxes. Some example measurements of turbulence around a wind turbine will be shown as well in order to showcase the potential of this UAV platform.