

THE UTILIZATION OF NUMERICAL FORECAST MODELS AND AIRBORNE DOPPLER WIND LIDARS FOR UAS FLIGHT PATH PLANNING AND ENERGY EXTRACTION.

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Abstract

Under funding from the US DoD (Army Research Laboratory), the researchers are developing a hardware/software package that combines pre-mission planning with a numerical model (WRF) and the real-time acquisition of atmospheric data AND detection of atmospheric features by a small light-weight airborne Doppler Wind Lidar (DWL) aboard a small manned aircraft or UAS. The main goals are to utilize model-driven preflight assumptions for initial planning but reduce mission dependence upon those assumptions and adapt to in-flight measured data. This could include optimize aircraft routing and flight path planning, extending flight duration and endurance, and the avoidance of hazardous features. In general terms, the airborne DWL is used as “eyes” to detect specific atmospheric energy targets. The lidar detected features are then used with the onboard, weather model driven flight control model to adaptively plan a flight path that optimizes energy harvesting with frequent updates on local changes in the opportunities and atmospheric flow characteristics. We have named this system and set of algorithms AEORA (Atmospheric Energy Opportunity Ranking Algorithm).

Robust algorithms for energy opportunity detection from the airborne lidar data for features such as thermals, cloud updrafts, shear zones, obstacle flow, mountain waves, OLEs and wind gusts are being developed using over 150 hours of relevant airborne DWL mission data (2002-2012) taken on a Navy Twin Otter aircraft based out of Monterey, CA. Another core task of AEORA is to rank those opportunities using cost/benefit considerations. The ranking considers the resources (fuel, altitude, electrical power, etc) to be expended getting to the energy target, the mission constraints and the potential energy gain from flying the available features. The target ranking is continuously updated with new DWL information based upon the distance to target, maximum height(or horizontal speed) gain potential, minimum energy loss and location relative to next likely target.

Once it has been determined where to fly, flight to target algorithms on board the aircraft will determine the path taken. We have developed flight control laws for four types of atmospheric features 1) lifting air centered about a point (thermals), 2) lifting air organized along a line (ridge lift, mountain waves), 3) wind shear, and 4) random turbulence.

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