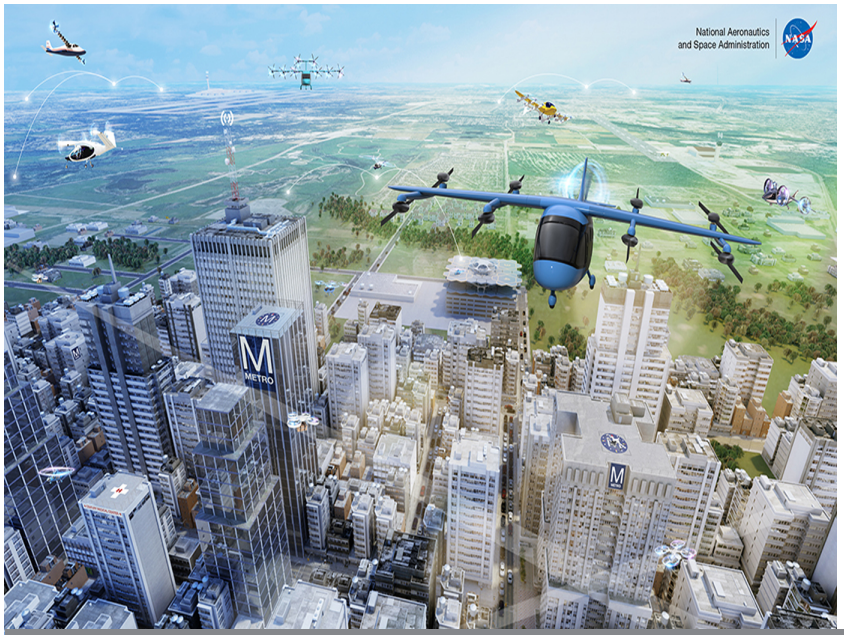


National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Aerospace

Wind-Optimal Cruise Airspeed Mode for Flight Management Systems (FMS)

A new energy-efficient speed mode for FMS

Energy-efficient flight is especially important for commercial viability of aviation. Even a small amount of fuel savings - 5% per flight - can be significant because of the scale of operations, with tens of thousands of flights per day in the US alone. Energy efficient flight planning is even more important for electric Vertical Takeoff and Landing (eVTOL) aircraft with battery powered distributed electric propulsion (DEP) systems because the low specific energy of the lithium-ion polymer (Li-Po) batteries necessitates energy-efficient flight planning. NASA's Ames Research Center has developed a novel speed mode for FMSs, a wind-optimal airspeed mode that optimizes route planning for minimum-energy usage based on actual and predicted wind conditions. Using real-time computation, an FMS can continuously update the wind-optimal airspeed target and try to maintain the optimal airspeed for current flight conditions for the entire cruise portion of the flight.

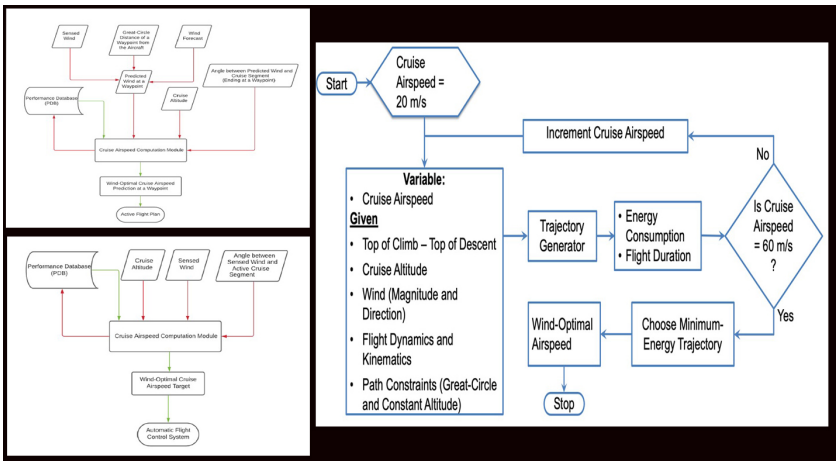
BENEFITS

- Energy efficient flight for eVTOL aircraft with Distributed Electric Propulsion (DEP) systems
- Reduced energy consumption of up to 7.5%
- Reduced fight duration of up to 28%
- Lower variability and higher predictability in energy consumption even under wind uncertainty
- Also useful for commercial, regional, and business jet aircraft types
- Incorporation of wind-optimal airspeed mode in the FMS enables the pilot to select and fly the aircraft at the wind-optimal airspeed autonomously

THE TECHNOLOGY

The novel approach for optimizing airspeed for both actual and predicted wind conditions in electric Vertical Takeoff and Landing (eVTOL) aircraft with Distributed Electric Propulsion (DEP) systems includes the process of creating a lookup table for wind-optimal airspeed as a function of wind magnitude, considering the direction of the wind relative to the cruise segment, considering the cruise altitude for an aircraft type, and incorporating the wind-optimal airspeed lookup table in the performance database for real-time access by the Flight Management Systems (FMS) to predict wind-optimal airspeed at waypoints of the flight plan. The target wind-optimal airspeed is updated in real-time throughout the cruise portion of a flight.

In a test of the wind-optimal airspeed targeting technique using a multi-rotor aircraft model, results obtained show benefits of flying at the wind-optimal cruise airspeed compared to the best-range airspeed. In headwind conditions, energy consumption was reduced by up to 7.5%, and flight duration was reduced by up to 28%. Under uncertain wind magnitudes, flying at wind-optimal airspeed offered lower variability and higher predictability in energy consumption than flying at best-range airspeed.



Top left: Real-time Wind-Optimal Cruise Airspeed Prediction at a Waypoint

Bottom left: Active Wind-Optimal Cruise Airspeed Target using the Flight Management System (FMS)

Right: Specific embodiment involving the NASA-proposed Multirotor to compute Wind-Optimal Airspeed

APPLICATIONS

The technology has several potential applications:

- Avionics Industry (Original Equipment Manufacturer):
  - FMS
  - Performance Management System (PMS)
  - Electronic Flight Bag (EFB
- Urban Air Mobility (UAM)/Advanced Air Mobility (AAM):
  - Provider of Services for UAM/AAM
  - UAM/AAM Operators
- Unmanned Aircraft System Traffic Management (UTM):
  - UAS Service Supplier (USS)
  - UAS Operators
- Aircraft manufacturing companies:
  - Electric Vertical Take-Off and Landing (EVTOL) aircraft
  - Unmanned Aircraft Systems (UAS)
  - Jet aircraft, turbo-prop aircraft, gas-electric hybrid aircraft and aircraft using alternative sources of power such as hydrogen

PUBLICATIONS

Patent Pending

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