TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Automation and Control Institute (ACIN)
Gusshausstr. 25-29
1040 Vienna
Austria
www.acin.tuwien.ac.at

Active turbulence suppression – SmartWings

Development of smart wing structures that measure atmospheric turbulence and suppress disturbance effects

Atmospheric turbulence is an unsolved problem for aviation impairing economy, safety and comfort. Current efforts to predict turbulence more accurately in order to avoid it by rerouting result in higher fuel consumption and CO2 emissions as well as reduced traffic volumes.

The operation of innovative vertical take-off and landing (VTOL) aircraft is particularly affected by atmospheric turbulence due to their low altitude and low inertia. This applies equally to unmanned vehicles for goods transport (delivery drone) and manned vehicles for urban mobility concepts of the future (flying taxi).

Objective

In the future it should be possible to fly through atmospheric turbulences directly and reliably. The SmartWings research project at TU Wien is investigating methods and technologies that are able to reduce the disturbance effects of turbulence, such as vertical accelerations, by as much as 80%.

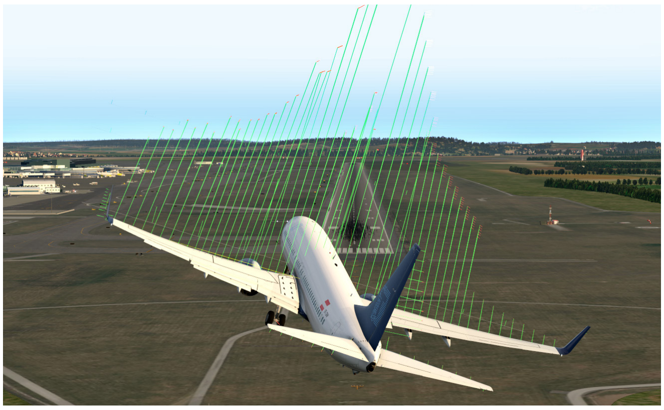
Approach

Smart wing structures measuring turbulences in front of the wing and actively adjusting their shape can suppress disturbance effects of atmospheric turbulences in flight. Calculating optimum flight control outputs from the measured data is a particular control engineering challenge. It is solved by a combination of model-based feedforward and feedback control.

Highly dynamic lift control: Through the application of direct lift control, the wing lift can be varied very quickly. A novel control procedure prevents secondary short-period oscillation and thus considerably increases the lifting effect that can be achieved.

Phase compensation: Using anticipating sensors, such as pressure measurements in front of the wing or wind LiDAR, it is possible to compensate system-related time delays and the disturbances precisely at the right moment.

Adaptive structures: Innovative materials and manufacturing methods enable the use of adaptive wing structures (morphing wings) in order to adapt the wing shape specifically to the external flow field.



Approaching aircraft in atmospheric turbulence – visualization of local lift distribution and drag

Resultus

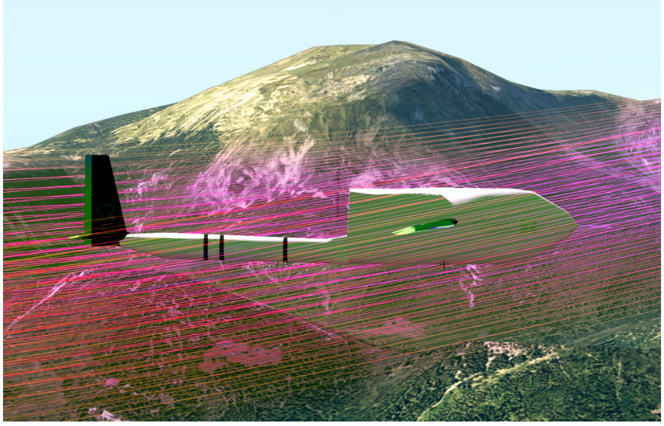
It is possible to achieve a significant reduction of interference effects due to atmospheric turbulence in flight as current research results indicate. A novel method, also filed for patent, increases the compensation effect of the lift by a factor of 10. Previous results of simulation and unmanned test flight indicate possible reductions of the disturbance effects by 80% compared to uncontrolled flight.

The execution of manned test flights is to ensure the transferability of the results to general and commercial aviation.

Applications

The methodology developed at TU Wien may be applied to fixed-wing airplanes of different sizes – from micro UAV to long-haul aircraft. An essential prerequisite for implementation is a digital flight control and technical equipment on the wing in order to vary the lift quickly. For this purpose, conventional wing flaps or, in the future, novel wing structures with adaptive elements may be used.

For VTOL aircraft, the use of direct lift is particularly interesting due to the similar functional principle of wing lift and vertical thrust in vertical flight.



Smart wings – adapting their shape to the airflow

Notes

Your benefits

For commercial aviation:

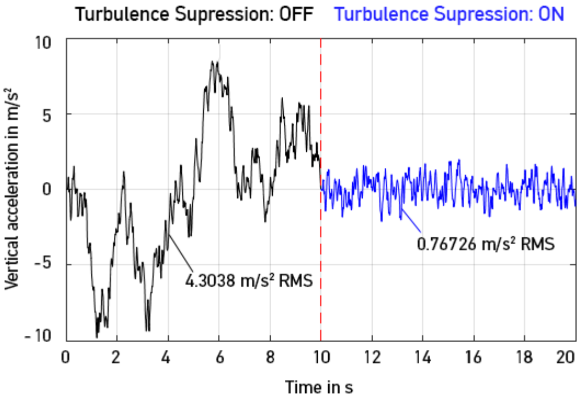
- reduced fuel consumption and CO_2 emissions – by up to 10%
- higher traffic volume
- improved travel comfort and flight safety

For vertical take-off and landing (VTOL):

- particularly efficient turbulence suppression due to parallel effect of direct lift and vertical thrust
- increased reliability and safety in operation
- building consumer confidence

For unmanned aerial vehicles (UAV):

- enabling missions with smaller aircraft
- increased reliability and safety in operation
- longer range



Disturbance acceleration of an aircraft in atmospheric turbulence without and with turbulence suppression

Contact

Univ.-Ass. Dipl.-Ing. András Gálffy
TU Wien – Automation and Control Institute (ACIN)
www.acin.tuwien.ac.at
Ph +43 1 58801 376 526
M +43 660 5592007
andras.galffy@tuwien.ac.at