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Title

Lidar-based Gust Load Alleviation – Results Obtained on a Generic Long Range Aircraft Configuration

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Abstract

Active control technologies are providing the opportunity to alleviate structural loads, to resize the aircraft primary structure and to save weight. A novel control approach such as a feedforward controller structure using lidar-based measurement signals enables to improve the gust load alleviation performance significantly [1]. A lidar sensor system is able to detect the atmospheric disturbances via scanning a spatial area ahead of the airplane. The obtained measurement data is processed afterwards by an estimation algorithm which provides detailed information of the upcoming wind field. The predicted data allows the feed-forward controller function to allocate additional commands to the control devices in advance to the arising gust, enabling to adjust the motion of the aircraft respectively to redistribute the lift of the wing previously to the gust strike and to reduce the angle of attack variations induced by the gust.

In this paper a lidar-based preview gust load alleviation controller is presented. The controller function is synthesized via modern robust control methods in discrete time and optimized for an industrial aircraft configuration called **G**eneric **L**ong **R**ange **A**ircraft. In comparison to [1], the GLRA dynamics are represented by a substantially increased set of linear models, altogether encompassing a wide range of mass distributions and flight points. Each single aeroelastic model is characterized by a detailed high-order modeling structure providing i.a. numerous wind inputs, control surface inputs and load outputs. The used modeling approach requires a comprehensive data processing, but also enables to discuss the load alleviation performance (and the general impact on the aircraft behavior) in a detailed manner.

The controller performance is tested in a realistic hybrid and multi-rate simulation environment [2]. Beyond the scheduled controller and the aircraft model, the environment comprises i.a. a sophisticated lidar sensor model [3] and bandwidth-limited actuator models. The load alleviation performance is evaluated for a wide range of mass distributions, altitudes, airspeeds and gust lengths, leading to results based on over 1000 analyzed gust load cases. The paper concludes with a discussion of the impact of the GLA control function on the structural loads, the load hierarchy and the general aircraft behavior.

References

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